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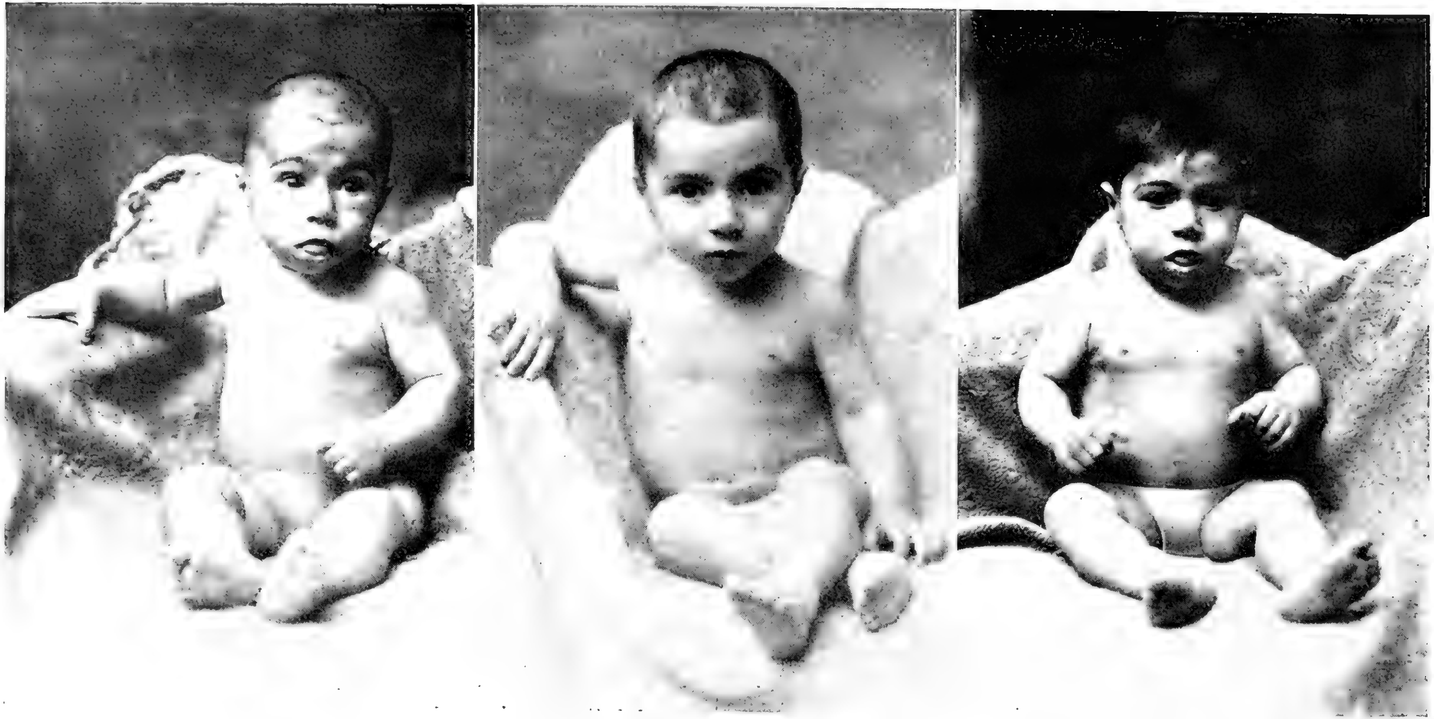


Before Treatment — Three Weeks of Thyroid Treatment — Treatment Discontinued Six Months

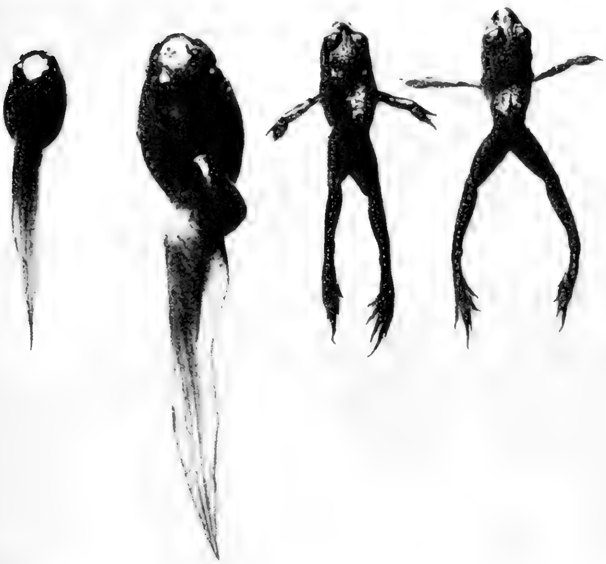
CRETINISM DUE TO THYROID INSUFFICIENCY

FRONTISPIECE. Cretinism is a disease chiefly of young children, caused by congenital absence of the thyroid gland, or to insufficiency of its secretion. Its outstanding symptoms are stunted growth of the body, even more stunted mental development, and thick, flabby skin. The feeding of thyroid extract results in the return of normal mental faculties, and in remarkably rapid physical growth. Treatment must be continued throughout life to prevent the recurrence of symptoms of cretinism. The thyroid gland appears to exert its influence through accelerating metabolism. Evidently the more highly differentiated tissues, especially those of brain and nervous system, are peculiarly dependent on an "internal environment," rich in thyroid secretion, for without it they fail to function properly. The above pictures show three views of the same child, and bring out clearly the almost unbelievable rapidity of the changes that take place when the proper amount of thyroid secretion is present in the body. After treatment had been continued for a time the parents removed the child from medical care, and before long symptoms of cretinism began to reappear. Photograph by Dr. Max G. Schlapp, Clearing House for Mental Defectives, New York City. See text, p. 11.

DUCTLESS GLANDS AND DEVELOPMENT--II*

Amphibian Metamorphosis Considered as Consecutive Dimorphism, Controlled by the Glands of Internal Secretion

JULIAN HUXLEY,
Oxford University, England



"CRETIN" AND NORMAL TADPOLES

FIGURE 1. On the left are two thyroidless tadpoles, showing extremes in size. On the right are two frogs from the same "brood," and of the same age as the tadpoles. The frog on the extreme right had his thyroid removed, but examination showed that part of the gland had been left, and this fragment was sufficient to produce metamorphosis. The distortion of the large tadpole's tail is an abnormality from which both normal and thyroidless tadpoles suffered, supposed to have been due to some impurity in the water. Lack of the thyroid gland does not have an adverse effect on the growth of tadpole tissues. In fact, "tadpole constitution" develops to an unusual size, but typically adult tissues are greatly retarded or do not develop at all. Photograph reproduced by permission of Dr. Bennett M. Allen, and the *Journal of Experimental Zoology*. See text, p. 11.

IF WE try to penetrate a little deeper, we shall be driven to the conclusion that, since the thyroid, so far as is known, has always as its main function the acceleration of general metabolism, the two types of internal environment really differ in regard to metabolic rate, the basal metabolism of the larval stage being less than that obtaining at metamorphosis. We then conclude that the larval tissues are adapted to live at a low, the

*This is the conclusion of Dr. Hurley's article on the causes of Amphibian Metamorphosis. The first part appeared in the preceding number of the JOURNAL.

adult tissues at a higher rate of metabolism, and that when the metabolic level is raised beyond a certain point, the larval tissues break down. That tissues are unable to maintain themselves in a functional state when certain alterations in conditions occur,—in other words, that they *dedifferentiate*—is well known. When all tissues dedifferentiate more or less simultaneously, there is a regression of the whole animal to a simplified state, as in Clavellina. When only some are affected, the result may be a complete resorption of the affected organs, due to migration of the cells into the cavities of the body;[9]* or a beginning of resorption followed by phagocytosis. It is this last method which appears to occur in Amphibian metamorphosis. By starving young tadpoles, I have been able to obtain localized dedifferentiation in small areas of the tail, the histological appearance being very like that which obtains at metamorphosis. In this case, phagocytosis only appears to obtain to a very small extent.

The Mechanism of Metamorphosis

The important researches of Champy have thrown a new light on the threshold values for different tissues. He finds that in frog tadpoles, after a single administration of thyroid, certain tissues respond by a *progressive* increase in the proportion of mitoses, others by a progressive decrease, while still others show no change in growth-rate. What is more, one and the same tissue may show localized areas of all three descriptions, distinguishable solely by their mode of reaction to thyroid-diet. In other words, the action of *thyroxin,* like that of so many other hormones, depends not only on its own specific properties, but also on specific properties of the tissues it affects. As we have said before, there are therefore two classes of variables to be kept in mind in dealing with any problem such as metamorphosis, into which the thyroid enters, variations in *thyroxin* concentration, and variations in the sensitiveness of the tissues.

If this is so, the primary mechanism of metamorphosis should be (a) an adverse effect upon the purely larval tissues, followed by their partial dedifferentiation, this followed by incipient resorption, and this by phagocytosis; (b) an acceleration in the rate of growth of all specifically adult tissues, which are those that are adapted to grow better at a higher rate of metabolism.

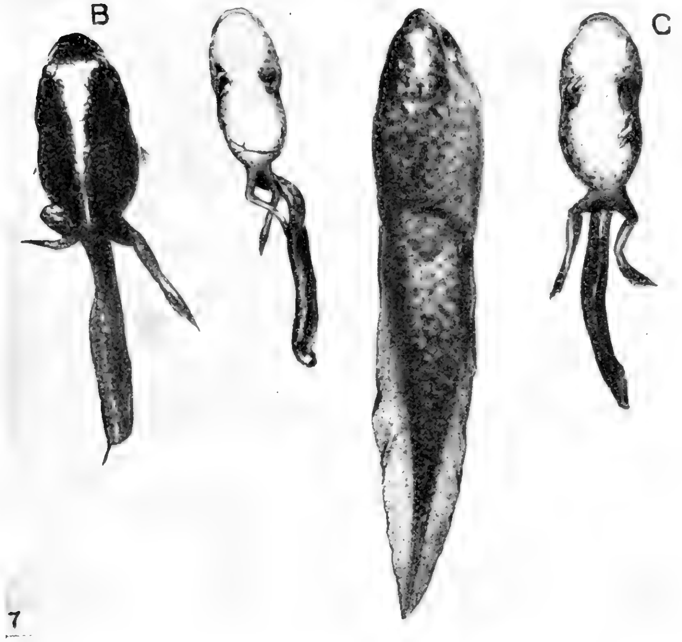
We have in this a general answer to our second principal question, as to the mechanism of metamorphic change. To pursue this point in detail would take us too far afield, and we must content ourselves with the very general statement that certain tissues have a lower optimum metabolic rate for maximum growth, others a higher, and that the former spontaneously break down when the rate is raised too far, their debris being cleared away later by the phagocytes.

Metamorphosed Amphibia, so far as known, show no important morphological changes when their thyroids are removed. If this is corroborated, it shows that the high concentration of thyroid is not necessary for the maintenance of adult structure in the same way that low concentration is necessary for the maintenance of larval structure, and emphasizes the irreversibility of metamorphic processes.

Bearing in mind the idea of the two internal environments, distinguished by different rates of metabolism, we may be able to grasp certain other of our problems more clearly.

In parenthesis, it may be observed that some recent writers, e. g., Swingle[15] and Kendall,[11] believe that the thyroid secretion acts in different ways in Amphibia and in Mammals, the metamorphic effect in the former being due solely to the iodine content of the thyroid hormone, the rise in basal metabolism seen in the latter being due to a specific iodized organic compound,

* For numbered references, see "Literature Cited" at end of article.



THYROID FED TADPOLES AND CONTROL

FIGURE 2. Larvae of the bull frog normally retain the tadpole form for two or even three years before metamorphosis takes place. The changes produced in the three "half-and-half" individuals shown were the result of twenty-six days of thyroid feeding. Notice the great decrease in size that has occurred, the tissues being literally broken down and burned up under the more rapid metabolism produced by increased concentration of thyroid secretion. Photograph reproduced by permission of Dr. W. W. Swingle, and the *Journal of Experimental Zoology*.

thyroxin. Allen[3] seems inclined to adopt the same view.

This hypothesis is based chiefly on the extremely important fact discovered by Swingle[16] and already referred to, that inorganic iodine produces metamorphosis in Anuran tadpoles, and this whether they are normal or have had their thyroids removed.

However, even in adult mammals it has been shown that inorganic iodine in the blood-stream is very rapidly taken up by the thyroid, and is quickly built into some specific organic compound (presumably *thyroxin*). In mammals, therefore, iodine is promptly elaborated by the organism to form part of a complex substance which is the thyroid hormone.

So far as one can judge, exactly the same process is at work in larval Anura. The provision of an amount of iodine greater than the normal, up to the highest concentration tolerated by the animals, results in an increase in the size of the thyroid, and in the amount of its colloid content.[15] On the other hand, when one large dose of thyroid substance is given as food, metamorphosis occurs, but the thyroid remains small, increasing very little, if at all, in volume.[4] In other words, an excess of thyroid hormone acts directly and does not require to be worked up by the animal's own thyroid gland, whereas an excess of free iodine, however great, is worked up by the animal's own glands, presumably into the normal thyroid hormone, before exerting its metamorphic effects.

The final startling discovery by Swingle, that inorganic iodine will metamorphose even thyroidless larvae, at first sight seems to militate against this view. However, as Swingle himself pointed out, it only implies that the general tissues of the body possess to some extent qualities which have been specialized in the thyroid tissue. Uhlenhuth[18, 19], justly points out that we know nothing of the fate of the iodine in the body and that it is easy to suppose that it is worked up as to believe that it acts directly. As a matter of fact, it is easier to believe the former, since Swingle's own results showed that thyroidless animals metamorphosed less rapidly than normal ones in the same concentration of iodine. This would be the case if the same processes were occurring in both, only less rapidly in the thyroidless ones, whereas it would not be so if the total concentration of iodine were the determining factor.

Metabolic Indicators

It must always be remembered that in the adult mammal complex self-regulating mechanisms are at work, which tend to keep the production of the active secretion of any gland within comparatively narrow limits. In the developing Amphibian, however, such regulatory machinery appears not to exist, so that it is easy to obtain a relative increase in the size and productiveness of a particular ductless gland. In the tadpole, therefore, iodine above the normal is incorporated into the thyroid; whereas, in the healthy adult mammal, the balance, after a comparatively small amount has been taken up by the thyroid, is excreted.

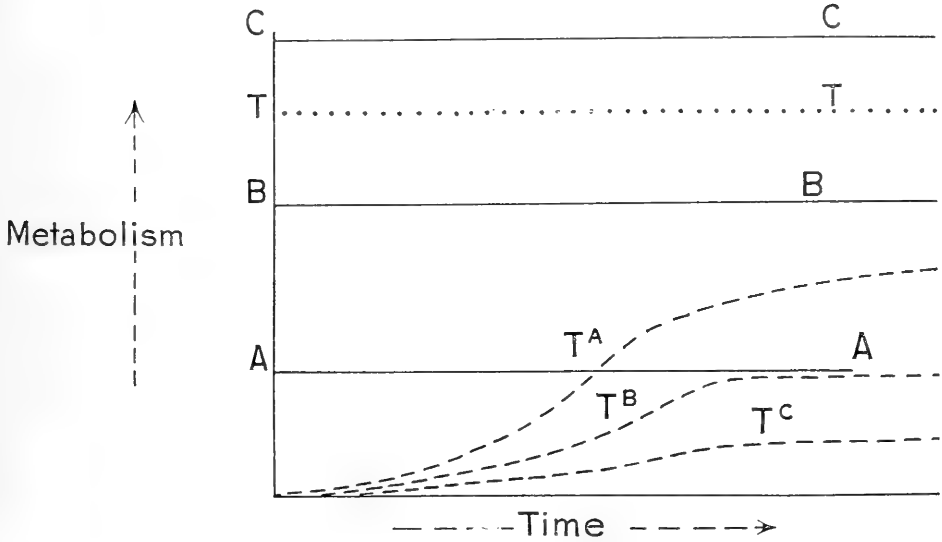
Taking all these facts into consideration, it is fair to say that in Anura, iodine, *during larval life at least*, is a limiting factor for the growth of the thyroid, so that with more iodine, more of the iodized organic compound is formed; further, that in thyroidectomized animals, the same or a similar organic compound is formed, but that it cannot be formed so rapidly or in such large quantities by the unspecialized general tissues as by the thyroid, which has been specialized for this particular function.

Further, the failure of iodine alone to produce metamorphosis in Axolotls and at least some other Urodela, whereas thyroid is effective, is impossible to reconcile with the hypothesis.

The evidence at present strongly indicates that inorganic iodine exerts any metamorphic effects it may have in Amphibia in the same way as it exerts any therapeutic effects it may have in Mammalia, indirectly, through the thyroid gland; and the onus of proving that the substance which exerts an effect upon Amphibian metamorphosis is not the same as that which causes a rise of basal metabolism in mammals, rests on those who propound such a theory.

This is of considerable importance, since, if the effect of thyroid upon Amphibiam metamorphosis is of the same nature as its effect upon human basal metabolism, the Amphibia, so soon as an accurate quantitative method is devised, can be used as "metabolic indicators," and will be of the greatest value as such; whereas they will not have this value to physiological science if the thyroid secretion acts on them in a different way from what it does in mammals.

If it is possible to have tissues which can only maintain themselves below a certain level of metabolism, it is equally possible to have similar tissues adapted to a higher rate, and thus not breaking down until a higher relative concentration of thyroid secretion is reached in the organism. It should equally well be possible to have tissues which did not undergo general breakdown (apart from some wasting away due to increased metabolism) under the influence of the greatest concentration of thyroid substance artificially producible in the organism, any more than do the adult tissues of Amphibia and those of mammals as



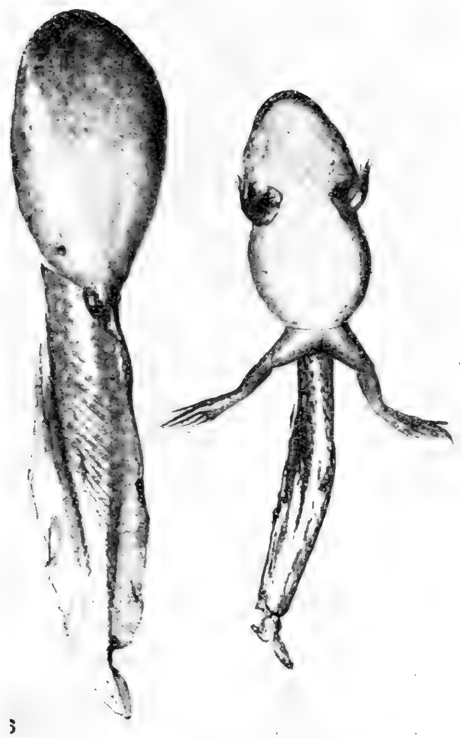
TISSUE SENSIBILITY AND THYROID FEEDING

FIGURE 3. A-A, B-B, C-C, tissue sensitivity (levels of metabolic rate at which breakdown of larval organs occur), in Anura, Axolotl, and Necturus, respectively; T-T, maximum metabolic effect possible to produce by thyroid feeding; Ta, Tb, Tc, curves of thyroid growth for Anura, Axolotl, and Necturus, respectively. Only in the case of Anura does the rate of thyroid growth enable it to secrete a sufficient concentration of thyroid to produce metamorphosis. By artificial thyroid treatment it is possible to increase the metabolic rate of Axolotls to the metamorphic point, but the greatest concentration of thyroid that Necturus will tolerate does not serve to break down the larval tissues.

the result of heavy thyroid doses. It would appear that it is in this way that Necturus, for instance, has become permanently larval in form and immune from the metamorphic effects of thyroid. In Proteus,[12] and Necturus,[17] the histological structure of the thyroid is normal, but its size, especially in Proteus, is relatively small. This in itself will render normal metamorphosis difficult or impossible, but it will not explain why no amount of thyroid treatment will induce metamorphosis. This latter fact, it seems to me, is only explicable on the assumption that a change has occurred in the other partner, so to speak, in the business of metamorphosis—the larval tissues—rendering them insusceptible of breakdown under increased metabolism. That larval tissues may thus differ in different species in their metabolic relations is shown by the interesting observation of Allen[3] that different species of Amphibia when thyroidectomized, attain different degrees of development before differentiation ceases; thyroidless *Bufo lentiginosus* larvae, for instance, attain greater limb-development than thyroidless *Rana pipiens* larvae.

In the Axolotl, the same two processes are probably at work. There is probably a relative insufficiency of thyroid secretion, and this relative insufficiency is due partly to an absolutely decreased rate of differentiation and a decreased end-size of the thyroid itself, partly to a change in the metabolism of the body in general; but neither of these changes seem to have gone so far as in Necturus. Experiments are now being undertaken to test the correctness of this view.

The longer time necessary to metamorphose a mature than an immature Axolotl by thyroid feeding, already alluded to, is interesting in this connec-



THREE WEEKS OF THYROID FEEDING

FIGURE 4. Control and thyroid-fed tadpoles after twenty-three days of thyroid feeding show the terrific acceleration in development that an increased concentration of thyroid secretion produces. Accompanying these external changes are even more remarkable internal ones. In two weeks, the undifferentiated alimentary of the tract of the tadpole decreased in length 246 milimeters (nearly ten inches), and from a simple tube differentiated into stomach, intestine, and the other parts constituting the digestive system of the normal adult frog. Photograph reproduced by permission of Dr. W. W. Swingle and the *Journal of Experimental Zoology*.

tion. The mature tissues, it would appear, do not break down so readily as the immature under the action of thyroid secretion. A rough diagram, which is intended only as a graphic symbol, may help clarify this argument. (Fig. 3.)

If we accept this view, we might expect to find that Anura, as the group in which metamorphosis is the most specialized, show an increased susceptibility of their larval organs to thyroid concentration. That this may possibly be so is shown by Uhlenhuth's discovery[19] that iodine in some Urodeles at least, is not efficacious in bringing about metamorphosis.

The fact that Axolotls and other Urodeles do not metamorphose under simple iodine treatment would then indicate, as suggested above, that their larval tissues are less susceptible to increase in basal metabolism, so that the limited amount of increase which iodine can bring about in the thyroid, even when free iodine is present in the greatest amount which the animals will tolerate, is insufficient to do what larger quantities of thyroid can effect.

Use of the Thyroid a Matter of Convenience

It is further clear that normal utilization of the thyroid by Amphibia as an initiator of metamorphosis is a matter of convenience, so to speak, not of necessity. When metamorphosis does occur, and there is therefore a marked consecutive dimorphism, the general problem is primarily of causing the larval tissues to break down at a given time, and secondly, of causing the more rapid growth of adult tissues. Whatever change of external or internal environment may be found which will promote this breakdown, may be utilized to promote metamorphosis.

In insects it is known that the whole type of metabolism alters at metamorphosis, indicating a pronounced qualitative change of internal environment. In Echinoids, the writer has recently suggested that the sinking of the larvae to the bottom, as the result of the increasing weight of the Echinus rudiment, may be the initiatory factor in metamorphosis, since the benthic environment is unfavorable to the larval tissues, adapted as they are to the totally different conditions of planktonic life.[10] If this should be sub-

stantiated, the change of environment which appears to initiate metamorphosis would here be external, not internal.

To revert, however, to our special problem of Amphibian metamorphosis. We have seen that the consecutive dimorphism of metamorphosis is comparable to that of certain types of hermaphroditism. It remains to point out that, if such were of advantage to the organisms, it would be easy, theoretically, to establish a simultaneous dimorphism similar to that of bisexual organisms. If in an animal like the Axolotl, for example, in which the balance between thyroid and other tissues is fairly close, a mutation were to occur that would result in bringing about metamorphosis, then if we call this the mutant factor T and the normal factor t, we should have metamorphosing animals of classes TT and Tt and neotenous individuals of class tt. It this condition were advantageous, it could no doubt be perpetuated, as is the dimorphism of Primula in regard to style-length. As a matter of fact, it is impossible to imagine that such a condition could be of biological advantage: none the less the illustration is useful as showing the very close connection which exists between the mechanism of metamorphosis and that of sex-dimorphism. I will not press the point; those interested can work out for themselves comparisons with gynomonoecism and various other kinds of sex-distribution.

A further interesting parallel with sex is provided by the unpublished observations of Dr. Hogben, to whom many thanks are due for permission to mention them. Certain combinations of anterior and posterior pituitary treatment, it seems, lead to the establishment of an apparently permanent state intermediate between the larval and the adult form, and comparable to the balanced triploid intersexes of Bridges' Drosophila (in *Science,* New Series 54:252, 1921).

Other Factors

The problem has thus far been simplified by omitting almost completely all references to other factors, which, like the pituitary, have an effect upon metamorphosis.[2, 7, 17, 14]

These, however, seem usually to produce this effect indirectly, by acting upon the thyroid, and can, therefore, for the purposes of an essay such as this, be logically included under the general heading "rest of the body," or the "general larval organization."

It is clear, however, that the "general organization" is very complicated, and that its effect on metamorphosis is theoretically separable into a number of single factors, all of which can be considered as coming into a relationship, whether positive or negative, with the effect of the single factor of thyroid-differentiation. In precisely similar fashion, the work of Bridges shows that as regards sex we have on the one hand the single factor (using the word not in its technical but in its general sense) of the sex-chromosome which may be present in single or in double dose, and on the other hand the operation of a number of factors, namely individual genes scattered throughout the autosomes, some exerting effects antagonistic, others effects complementary to that exerted by the sex-chromosome.

It is clear that the more we know about these individual factors, the further will our analysis proceed. What I would specially like to point out is this: metamorphosis provides a clearly defined and easily recognizable reaction, which throws light on certain important processes occurring in the organism; it may in this respect be compared with the visible reaction of litmus or other indicators to changes in hydrogen-ion concentration.

The Physiology of Development

But what is of special interest, if the views that I have been expressing are well-founded, is that the phenomena

for which metamorphosis acts as an indicator are processes of differentiation and that it is their *relative rates* which are important. We are introduced to a possibility of studying by experimental means a field which so far has scarcely been accessible save to observation—I mean the time-relations of development. So far, the science of Developmental Physiology has sought to establish simple causal relations between particular developmental happenings within or without the organism. It has established the optimum, minimum, and maximum temperatures for the development of many organisms, the chemical substances necessary for growth, the abnormalities produced by alterations in the medium. It has further found that certain organs may exert "formative stimuli," to use Herbst's well-known phrase, upon the development of other organs. Classical examples of these are the influence of the optic cup of vertebrates upon lens-formation, and the influence of the optic ganglion and antennary centre of Crustacea upon the form of the structure regenerated after the eye-stalk is cut off.

But Developmental Physiology can hardly be said to have entered upon its quantitative phase. To do this, it is essential that we think in terms similar to those introduced into chemical science by the methods of Physical Chemistry. We must think in terms of *processes and relations between processes.* The physiology of development is quite different from the physiology of adult life, since the latter is mainly concerned with the regulation of the functions of the body so that they do not depart beyond certain limits from the normal. Developmental Physiology, on the other hand, is concerned, not with constancy, but with change; during development continually new structures and functions are appearing, each phase proceeding to a point at which it resolves itself into a new and qualitatively different phase; and the regulation that exists is concerned with the proper sequence of these phases in such a way that a normal adult is the outcome.

Thus if *Entwicklungsmechanik,* or Developmental Physiology, wishes to become accurate, it must concern itself with the *speed* and the *equilibrium* of processes. Time-relations on the one hand, interaction on the other—these are the two chief points with which it must deal. We have seen that metamorphosis depends upon the time-relations, *inter alia,* of thyroid-differentiation; we have also seen that the inter-relation of thyroid differentiation with other developmental processes has to be considered. This point of view has been introduced into general biology mainly by Goldschmidt's work on consecutive intersexuality. It is, I think, safe to prophesy that Amphibian metamorphosis will provide the most favorable field for the next steps in its cultivation. There are many clinical observations on mammals and man which await elucidation from such a quantitative study of Developmental Physiology: variations in the onset of puberty; pathological sexual precocity; infantilism; progeria; premature senility and so forth.

In conclusion, one or two points may be touched upon which these general considerations help to illuminate. We have seen that it is a fallacy to think of the thyroid as having a specific metamorphosis-producing effect. In the same way, it is a fallacy to think of it as being a specific growth-promoting agent. This idea has gained currency owing to the fact that cretins are permanently stunted in growth, and that early thyroid administration often causes normal growth to be resumed. A physiologist with whom I was conversing recently was much surprised—one could almost say horrified!—on hearing that thyroidectomy did not adversely affect the growth of tadpoles.

The fact of the matter appears to be, as we have seen, that certain tissues grow well at a low level of thyroid concentration, others at a high level.

Among those which appear to need a high level, those composing the human brain are prominent. Many of the stunting effects of cretinism are quite probably secondary, due to the absence of the normal trophic effects of the stunted nervous system; (compare the experiments of Forsterling on similar secondary stunting due to x-ray treatment of the brain region in mammals). In a precisely similar way, the human brain requires a high temperature to work properly; lowering its temperature a few degrees will bring about a failure of consciousness. Similarly, it is so familiar as often to escape notice that a high temperature and consequent general rapidity of metabolism is necessary for development to occur at all in mammals and birds; their development ceases at a temperature still above the optimum for that of Amphibia.

In this connection, it is interesting to note that the relative size of the thyroid is stated to increase progressively in the different classes of Vertebrates, being smallest in fish, and largest in warm-blooded animals. To put it as crudely as possible, "frog-constitution" without thyroid only becomes a tadpole; "man-constitution" without thyroid becomes a cretin. The difference between the two cases is that one is pathological, the other is not. This difference between the requirements of the tissues of tadpoles and those of warm-blooded Vertebrates should not be forgotten when estimating the value of experiments with tadpoles as a means of throwing light on human physiology.

Summary

(1) Amphibian metamorphosis is considered as a transition between two phases in a consecutive dimorphism, and as initiated by a change in internal environment.

(2) The similarity of metamorphosis to the sex-change in protandric and protogynous hermaphrodites and in Goldschmidt's intersexual moths is emphasized; the dimorphism of sex is associated, like that of metamorphosis, with differences in internal or external environment.

(3) The similarity of the breakdown of larval tissues to that of the tissues of lower organisms in dedifferentiation and resorption is pointed out.

(4) Amphibian metamorphosis is probably determined by the relation between thyroid differentiation and the processes involved in the general metabolism of the rest of the larval body.

(5) Through the study of Amphibian metamorphosis, we are enabled to study the processes of differentiation quantitatively as regards their individual rates, and their interaction with each other.

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STERILE ST. REGIS-CUTHBERT HYBRID

FIGURE 5. Both parents belong to the same species, with possibly a slight admixture of "foreign blood," in the Cuthbert. Nevertheless many of the hybrid plants are sterile. This would be expected in a "wide" cross between unlike species, but is quite unusual in crosses between closely related varieties.

A YELLOW-FRUITED "PURPLE-CAP"

FIGURE 6. This yellow-fruited plant is the result of a cross between two pale-fruited varieties of a normally dark-fruited species. All of the plants of this cross were yellow-fruited, vigorous, and showed the peculiar habit of growth of the hybrid purple cap, *Rubus neglectus*.

RASPBERRY BREEDING NOTES

Paul Thayer

Pennsylvania State Agricultural College, College Station, Pa.

THERE is growing wild in the vicinity of the Ohio Agricultural Experiment Station at Wooster a yellow-fruited form of the common blackcap, *Rubus occidentalis*. Having in the variety trial-plots of the Station plants of the Golden Queen, which is virtually a yellow-fruited Cuthbert, the writer was curious to see what would be the result of crossing these two yellow-fruited representatives of normally dark-fruited species. Reciprocal crosses were made. The Golden Queen pollen worked well on the Yellow Cap, but the Yellow Cap pollen on the Golden Queen gave few fruits and the resulting seedlings were such as to cast a doubt upon the work. Of the two dozen Yellow Cap × Golden Queen seedlings every one was yellow fruited and all, with one possible exception, showed the extreme vigor and peculiar habit of growth of the hybrid "purple-cap" or *Rubus neglectus*. The fruit was larger than that of the parent Yellow Cap, as well as more juicy, and with the typical *neglectus* flavor. In color it was the faint pinkish yellow of the Golden Queen. This suggests that the yellow color may not be a true color but rather an absence of color or a sort of albinism. It also suggests the possibility of breeding out the unattractive "purple" color of the purple-caps and securing red-fruited or black-fruited *neglectus* varieties by using a yellow-fruited form for one parent in hybridizing, and thus permitting the other to impress its color on the offspring.

Another line of work followed was the crossing of Cuthbert and Ranere (St. Regis) in the hope of securing a seedling with the autumn-bearing habit of the Ranere and the other characters of the Cuthbert. The outstanding result of this work was the high per cent of seedlings with sterile blossoms. In the Ranere × Cuthbert seedlings one in seven was sterile. While in the Cuthbert × Ranere seedlings eleven out of twenty-four bore sterile blooms. Such a high degree of sterility is strange in view of the close relationship of the two, both being *Rubus strigosus*, with the possible admixture of some *idaeus* blood in the Cuthbert. Especially is it to be wondered at when one thinks how readily both *strigosus* and *idaeus* unite with each other as well as with *occidentalis*.

The Human Machine

Man, The Animal, *by* W. M. Smallwood, Professor of Comparative Anatomy, Syracuse University. Pp. 223+xiv; $2.50. The Macmillan Company, New York, 1922.

From earliest childhood we are all vitally interested in the working of the machine that is our body. The answer to the question, "What makes it go?" is so complicated that many of us fail ever to understand our own intricacies. Dr. Smallwood's book gives us much valuable and useful information about ourselves in a form that can be easily understood. Starting with the law of biogenesis, he traces the unity of life from amoeba to man and shows how the same fundamental laws apply to all living things. Thirty-two photographic illustrations and many line drawings

add greatly to the charm and interest of the book.

While he takes great pains to make clear man's close kinship to all living things and emphasizes the chemical and physical laws that are the "physical basis of life," the author does not adopt the views of the extreme mechanistic school. In particular one statement deserves consideration by those who feel that the existence of a "physical basis of life" is sufficient to "explain" life: "The biologist starts with life as it now exists, just as the physicist starts with energy and the chemist with atoms on all their infinite complexity. They do not try to *explain* energy and oxygen and carbon."

Nearly half of the book is given up to discussion of heredity or related matters. The final chapter, *Biology and Progress,* deals with the application of what man has learned about life and heredity to every day affairs. Summarizing, the author says: "In this brief sketching of some of the more probable fields of progress which will give a better understanding of man, no revolutionary changes are anticipated, nor is it suggested that fundamental laws will be altered. Progress must rather be in conformity with those principles which clearly indicate that we must recognize the ineradicable influence of heredity and that the right of being well born has a scientific foundation; that good food and a wholesome environment play an important part in well being; . . . and that mankind cannot set aside these basal relations."

Most of the author's views would receive the approval of students of heredity, but before leaving this excellent book, attention should be called to one or two statements that possibly are not altogether clear. In explaining Mendelian inheritance he says: "When the peas of this (first) hybrid generation are planted, the plants are partly tall and partly short, but none are intermediate. In the subsequent breeding of this experiment the short peas give rise to short peas and the tall ones to tall peas," which is a result that would hardly be expected by the scientific breeder.

Certain of his views on evolution might also be questioned by many students in this field. After remarking that artificial breeding has produced no new species, he adds: "This seems to mean that the more than hundreds of thousands of genera and species became fixed before man had thought seriously of questioning their origin. The result is that the life of today is highly specialized and adapted to a given environment. This gives a non-plastic series of forms to deal with, and science has been thus far utterly unable to reconstruct the conditions under which the former changes took place." It is hard to see why the present living forms should be considered any less plastic than their ancestors. Evolution is not something that happened in the past, but a vital, living force today. *The Origin of Species* was published only about half a century ago, and evolution has been studied experimentally for only the last twenty years. True, the problem is not yet solved, but that no progress has been made, few students of evolution would be willing to admit.

HEREDITARY SHORTNESS OF THUMBS

J. K. Breitenbecher

University of Oklahoma, Norman, Oklahoma[1]

THE SHORT THUMBED HANDS

Figure 7. The tip of the normal thumb comes nearly to the first joint of the index finger, but this thumb extends scarcely beyond the knuckle. The thumb-nail is also very short and broad. The inheritance of this trait has been traced for five generations and at least one child of every short thumbed individual had thumbs of this kind. The hands shown above are those of the man designated Abnormal 7 in the article. His hands were taken as a standard in comparing the differences between short thumbed and normal hands. An x-ray photograph of the same pair of hands is shown in Figure 8.

It has been about ten years since the writer made the first observations upon the abnormality which is described in this paper, namely a human hand in which the thumb is disproportionately short. During these years information has been collected, whenever the opportunity presented itself, by personal observation. Since the abnormal character has been traced through five generations, it is thought feasible to publish all data at present, rather than to withhold it for further information.

One sees, upon external examination, a hand that is long and narrow when compared with the normal; but the most clearly distinguishable characteristic about this hand is that every individual affected manifests a thick, short thumb with a nail that is very broad and short (about three-quarters of an inch in width and five-sixteenths to three-eighths of an inch in length).

To determine the amount of variation in the normal thumb, the writer made outline drawings of palmar views of several hands, consisting of random samples taken from college students and from the normal members of the short-thumbed family. Each sketch was made by placing the hand on a sheet of paper, and with the aid of a pencil outlining the hand by marking the outside of each finger.

[1] Contribution from the Zoological Laboratory of the University of Oklahoma, Second Series, No. 28.

X-RAY OF THE SHORT THUMBED HANDS

FIGURE 8. The long bones of the palm of the hand are termed metacarpals, the three finger bones are the phalanges, the first phalanx being at the base of the finger. While this picture is slightly more reduced than that of the normal hand (Figure 9), it enables direct comparison to be made between the bones of the two hands, as the reduction is such that the metacarpals of the thumbs of the two hands are of exactly the same length.

The result of this observation indicates that on the average the end of the normal thumb coincides with the joint at the union of the first and second phalanx of the index finger. The abnormal members of this family have thumbs the ends of which, on the average, coincide with the joint at the junction of the metacarpal and first phalanx of the index finger. Briefly, the abnormal thumb is shorter than the normal by the length of the first phalanx.

To study this abnormality in greater detail and to determine the internal effects of this mutation, it seemed desirable to have x-ray pictures of the hands of one of these affected individuals. This radiograph was then compared with two radiographs of normal thumbs, as well as with three skeletons. It was thought possible that the shadows of the bones might interfere with the technique of measuring, but it was found that a radiograph is a source of information as accurate as the bones themselves.

A comparative analysis was made with one abnormal (Abnormal 7) and the five above-mentioned normal right hands, by measuring the length of the bones of each digit. Complete data regarding these measurements are given in Table 2. The number of hands measured in all was six pairs,

A NORMAL HAND

FIGURE 9. The comparison between short and normal thumbs was made by taking the average of the measurements of the bones of five normal hands. The metacarpals of the short thumbed hands were found to be longer, and the terminal phalanx of the short thumb much shorter than the corresponding bones in the normal hands. It is this short phalanx of the thumb, and the unusually long metacarpals of the fingers that are inherited.

of these the first five were normal; the sixth measured was a radiograph of Abnormal 7. From a comparison of the abnormal with the five normal pairs, one discovers a difference in the metacarpals, and in the second and third phalanges, but much closer agreement in all six pairs of hands as regards the first phalanx. Because of this approximate agreement it seemed that the essential relations could be brought out better by expressing all measurements as ratios in terms of the first phalanx of the digit in question. These ratios are given on the right of Table 2, under the heading, "Calculated ratios."

To obtain a more direct comparison between the abnormal and normal bones of each digit, the ratios obtained for the five normal cases were added together and an average normal ratio obtained. These averages for the normal bones are compared with the

abnormal in Table 3. The ratios here tabulated show that the metacarpals of the abnormal hands are longer in proportion to their first phalanges than are the average of the metacarpals of the normal hands. The metacarpal of the abnormal thumb is actually about one-seventh longer than the average of the five normal first metacarpals. The last phalanx (Phalanx 2) of the thumb, however, is almost one-half shorter than the corresponding joint of the normal thumb. It is because of this fact that the thumb appears so short when compared with a normal thumb and, moreover, it is this short phalanx which is inherited in this family. It appears also that the second phalanx of each of the digits of the abnormal is relatively shorter than those of the normal. Compensatory regulation occurs in the appearance of the fingers, since the extra length of the metacarpals is balanced partially by the short phalangeal joints. The last phalanx of the abnormal digits bears no definite relation to the last phalanx of the normal, since it is sometimes longer and sometimes shorter in relation to its first phalanx.

THE OLDEST OF THE SHORT THUMBS

FIGURE 10. The woman designated Abnormal 2 is now nearly eighty years old, and remembers well that her mother had short thumbs, for they both had to use especially short needles in sewing. Beyond this it has been impossible to trace the character, but the evidence indicates that for five generations it has been inherited as a Mendelian dominant.

History of the Short-Thumbed Family

The record of these short thumbs, according to the writer's information begins with a woman (Abnormal 1) who has long been dead. Her daughter (Abnormal 2) when 78 years of age, said that she well remembers that her mother had short thumbs on both hands and, moreover, that both she and her mother always used especially short needles in sewing, because long ones would break in their hands. This peculiarity is correlated with shortness of thumbs.

The following is a brief record of the occurrence of the character in this family:

Abnormal 1, a woman, married a normal man. She had two abnormal children (Nos. 2 and 3), two normals, and four who died as infants.

Abnormal 2, sister of Abnormal 3, married a man with normal hands. Her offspring were two abnormals (Nos. 4 and 5), five normals, and three who died in infancy.

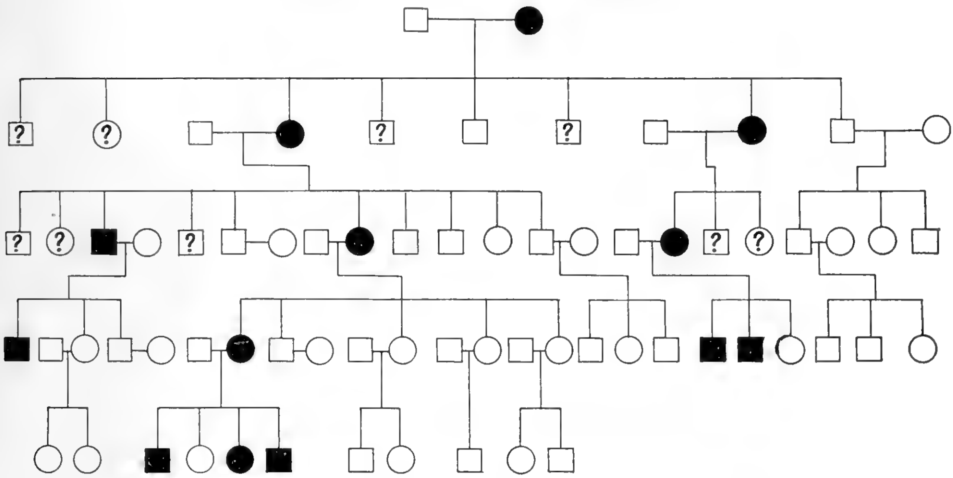
Abnormal 3, daughter of 1, was married to a normal man. They had one abnormal daughter (No. 6) and two children who died as infants.

Abnormal 4, son of 2, married a normal woman, and they had one abnormal child (No. 7), and two other children who were normal.

Abnormal 5, daughter of 2, married a normal man. This pair produced one abnormal daughter (No. 8) and four normal children.

Abnormal 6, daughter of 3, married a normal man. She had two abnormal sons (Nos. 9 and 10) and one normal daughter.

Abnormal 7 is unmarried.



INHERITED FOR FIVE GENERATIONS

FIGURE 11. Circles represent women, squares, men. Short thumbed individuals are indicated by solid black; a question mark shows an individual who died in infancy, about whose thumbs nothing is known. It is evident from the chart that the character is as likely to appear in one sex as in the other. A study was also made of the members of the family who had normal hands, and among their descendents not a single individual having short thumbs was found.

Abnormal 8, daughter of 5, married a normal man. Their offspring consisted of three abnormals (Nos. 11, 12 and 13), son, daughter, and son, respectively, and one normal daughter.

Abnormals 9, 10, 11, 12 and 13 are not old enough to be married.

To summarize the appearance of abnormals with reference to generations: the first generation begins with No. 1 and in the second generation Nos. 2 and 3 appeared. Abnormals 4, 5, and 6 were in the third generation, and in the fourth generation were Nos. 7, 8, 9, and 10. Lastly, Abnormals 11, 12, and 13 appeared in the fifth generation. Thus for five consecutive generations the trait has appeared.

The writer also obtained complete pedigrees of normals mated with normals in this family, but to give the complete data and family histories for such normals would require too much space and possibly be of little value. The results of this investigation can be summarized by stating that whenever normal members of the family married other normal individuals there were no abnormal children. Every individual with an abnormal hand had one abnormal parent. As the other parent, in every case, was normal, all of the abnormal individuals must have been heterozygous.

Discussion

It seems that this character is the result of a mutation which appeared more than five generations ago. If the abnormality in this family is a part of the normal variation in length of thumbs that is to be expected, it is true that some short-thumbed individuals should be discovered among the hundreds of people examined. It further appears that shortness of thumbs is a mutation because its range of variation differs from the normal.

The results given in Table 1 indicate that this character is a Mendelian dominant, the normal being recessive. If we represent the homozygous dominant trait by (AA) and the recessive, normal, by (aa), it is apparent that all offspring from the modification

should give a 1:1 ratio, because in every instance an abnormal individual was mated with a normal. Thus every abnormal person was heterozygous (Aa) and every normal homozygous (aa).

Table 1 further shows that matings of heterozygous (Aa) individuals with normal persons (aa) gave as a total 9 who died in infancy, 12 abnormal children and 15 normal. Of those who died as infants some at least might have had the abnormal character linked with the mortality; however, if this interpretation is not correct, the law of probability would lead us to expect that half of those individuals who died in infancy would be normal and the others abnormal. It therefore seems desirable to omit those who died as infants from any further consideration.

Following this suggestion the author tabulated in Table 4 the Observed Data, Observed Ratio, Theoretical Ratio, and Probable Error. The conclusion is that the observed ratio is a good fit because the number of normals and abnormals give a 1:1 ratio, which proves that in this family all abnormals are heterozygous, while the normals are homozygous recessives.

Other Abnormalities of the Skeleton

The many human pedigrees which have been published show that the majority of hereditary abnormalities found in the skeleton are inherited as Mendelian dominants. Davenport[1] enumerates several in this connection. One of the most common is polydactylism, by which is meant supernumerary fingers and toes; another abnormality is syndactylism, which means that the bones and tissues of two or more fingers are fused or webbed into one mass; while another is brachydactylism, which may be defined as an abnormality having digits and limbs exceedingly short. Cushing[2] has added another to this list of dominants, symphalangism, which means that the proximal phalangeal joints become fused. Another dominant is that of achondroplasism, described by Davenport[1] as a condition in man characterized by abnormally short limbs, as is osteopsathrosis or hereditary fragility of bones as shown by Davenport and Conard[3]. Lastly, hereditary shortness of thumbs as described in this paper is another abnormality of the skeleton which is dominant.

Summary

The character is neither sex-limited nor sex-linked, because it is found in both sexes, and is not transmitted from a man through his daughters to one-half of their sons. The evidence presented indicates that it is an autosomal Mendelian dominant.

TABLE 1. *The character of the offspring of the eight abnormal parents. The matings were in every instance between an abnormal (Aa) and a normal (aa).*

Parents	Progeny		
Abnormal No.	Died in infancy	Adults Abnormal	Normal
No. 1........	4	2	2
No. 2........	3	2	5
No. 3........	2	1	0
No. 4........	0	1	2
No. 5........	0	1	4
No. 6........	0	2	1
No. 8........	0	3	1
Totals....	9	12	15

[1] DAVENPORT, CHARLES B. *Heredity in Relation to Eugenics.* 298 pps. Henry Holt and Company, New York. 1911.

[2] CUSHING, HARVEY. Hereditary Anchylosis of the Proximal Phalangeal Joints (Symphalangism). *Genetics* I: 90-107. 1916.

[3] DAVENPORT, CHARLES B. and H. S. CONARD. Hereditary Fragility of Bone (Fragility Osseus, Osteopsathyrosis). *Eugenics Record Office Bulletin* 14. 31 pps. 1915.

TABLE 2. *Length of the bones of six right hands, five normal and one abnormal (Abnormal 7). The lengths are given in millimeters in columns two to five. The ratio of each measurement to the length of the first phalanx of the digit in question is given in columns six to nine.*

	Observed Data				Calculated Ratios			
Normals	Meta-carpel	Phalanges 1	2	3	Meta-carpel	Phalanges 1	2	3
1 (X-ray)								
Digit 1	46.5	31.5	24.5	....	1.476	1	.777	....
" 2	70.5	40.5	24.0	19.0	1.753	1	.592	.469
" 3	70.5	46.5	29.0	19.5	1.516	1	.623	.419
" 4	64.0	43.5	28.0	20.0	1.471	1	.643	.459
" 5	56.0	34.0	20.0	17.0	1.647	1	.588	.500
2 (X-ray)								
Digit 1	49.0	34.8	25.0	....	1.410	1	.719	....
" 2	74.0	43.0	25.5	18.0	1.721	1	.593	.419
" 3	71.0	47.5	31.0	19.0	1.505	1	.652	.400
" 4	66.0	45.0	29.0	20.0	1.467	1	.644	.444
" 5	61.0	37.0	22.0	18.5	1.648	1	.592	.500
1 (Skeleton)								
Digit 1	43.0	30.0	22.0	....	1.433	1	.733	....
" 2	69.0	39.0	23.0	16.0	1.769	1	.587	.415
" 3	65.0	43.0	28.0	17.5	1.511	1	.651	.407
" 4	60.0	41.0	27.0	18.0	1.463	1	.658	.439
" 5	51.0	31.0	18.5	16.0	1.645	1	.596	.516
2 (Skeleton)								
Digit 1	48.0	33.0	23.5	....	1.484	1	.712	....
" 2	72.0	42.0	25.0	17.0	1.714	1	.595	.405
" 3	69.5	46.0	30.0	18.5	1.510	1	.652	.402
" 4	64.0	43.0	28.0	18.0	1.488	1	.651	.419
" 5	54.0	33.0	20.0	16.5	1.637	1	.606	.500
3 (Skeleton)								
Digit 1	37.5	26.0	20.0	....	1.442	1	.769	....
" 2	58.0	34.0	19.5	15.0	1.706	1	.573	.470
" 3	55.5	37.0	23.0	15.0	1.500	1	.649	.405
" 4	51.0	35.0	23.0	15.0	1.457	1	.657	.429
" 5	43.5	26.5	16.0	15.0	1.642	1	.603	.527
X-ray Abnormality 7								
Digit 1	53.0	32.0	13.0	....	1.637	1	.406	....
" 2	81.0	41.0	22.0	17.0	1.931	1	.536	.414
" 3	76.0	50.0	26.0	21.0	1.520	1	.520	.420
" 4	65.0	44.0	28.0	21.0	1.477	1	.637	.477
" 5	60.0	35.0	19.0	18.0	1.711	1	.542	.514
	....	....	....	....	....	..	....	....

TABLE 3. *A comparison of the measurements of an abnormal hand (No. 7) with the average of those from five normal hands.*

Digit	Hand	Metacarpel	Phalanx 1	Phalanx 2	Phalanx 3
1	Normal Av.........	1.461	1	.742	....
	Abnormal	1.637	1	.406	....
2	Normal Av.........	1.732	1	.592	.435
	Abnormal	1.981	1	.536	.414
3	Normal Av.........	1.508	1	.645	.406
	Abnormal	1.520	1	.520	.420
4	Normal Av.........	1.469	1	.650	.438
	Abnormal	1.477	1	.637	.477
5	Normal Av.........	1.643	1	.595	.500
	Abnormal	1.711	1	.542	.514

TABLE 4. *Ratio of normal to abnormal individuals in the short-thumbed family.*

Trait	Observed Data	Observed Ratio	Theoretical Ratio	Probable Error
Abnormal	12	.8889	1	0.129
Normal	15	1.1111	1	0.129
Totals........	27	2.0000	2	

Social and Biological Heredity

SOCIAL CHANGE, by WILLIAM FIELDING OGBURN, Professor of Sociology at Barnard College. Price $1.50. B. W. Huebsch, New York. 1922.

A careful discrimination between biological and cultural changes characterizes this book. Professor Ogburn is himself convinced and convinces his readers that the failure to make such discrimination in the past has been the cause of much confused and faulty thinking. Why is there such a thing as social progress at all? Why new cultures, new inventions, new acquirements? Is it due to the evolutionary development of human biologic structure or is it due to other causes—cultural influences under which or through which man is called to pass? Such questions are intimately discussed and the result is illuminative.

We are especially impressed by an illustrative item by which the author explained his thesis as to the fact of a cultural progress in the race wholly separate from any biologic change in individuals. It was a list carefully compiled of some one hundred and fifty instances of duplicate inventions—of inventions made at the same time by two or more students or experimentors. The conviction was inescapable that inventions come, inevitably, at certain stages of culture, not because there happened a single individual of greater mental capacity, but because social conditions were at a stage when such inventions were both needed and were possible on the basis of preceding discoveries. Then, evidently, they came, and to more than one mind. It has been social progress rather than progress of individual gifts that has given man his great discoveries.

The two sections of the book, the first on the why and how of social change, and the second on the why and how of the drag or slow process of that change, are each of them interesting both in themselves and in the suggestive illustrations drawn from studies of contemporary facts or timely problems. —R. E. C.

COLOR INHERITANCE IN FOWLS

The Genetic Relationship of the Black, Buff and Columbia Colorations in the Domestic Fowl

L. C. Dunn
Storrs Agricultural Experiment Station[1]

THE VAST array of variations in color, pattern and form of feathers and other parts, which is observed in the domestic fowl, has made it enticing material for many students of variation and heredity. A great deal of information on the inheritance of many of the characters which distinguish the various breeds has been accumulated since Bateson first took up the study shortly before the rediscovery and application of the Mendelian method of investigation. A large part of the field of poultry genetics is still, however, unexplored country. We are still ignorant concerning the inheritance and relationships of some of the most obvious traits which differentiate our common varieties.

The present article describes the results of some experiments which were designed originally to furnish data on a certain class of heritable characters in fowls, namely those which are transmitted in the peculiar fashion known as sex-linked. Several such characters are known in fowls, but concerning the relations between them, or how their expression is altered by other characters we have but little information.

Columbian and Buff Color-Factors

The author's first experiments, which have been partially reported elsewhere[2], consisted in a study of the relationships between two well-known color patterns which exist in several breeds of fowls. One of these colorations is known as Buff (Figs. 13 and 14), in which the whole plumage of both sexes is an even shade of buff, with an occasional and generally unnoticeable trace of black in the tail feathers, and more rarely in the wings. This coloration is a varietal characteristic of Buff Plymouth Rocks, Buff Orpingtons, Buff Leghorns, and others. The other type used was Columbian (Figs. 12 and 13), a pattern consisting of clear white surface color in all of the plumage except the primary or flight feathers of the wings, the hackle or upper neck feathers, and the tail feathers which in typical Columbian fowls are marked with black. This pattern occurs in Light Brahmas, Columbian Wyandottes, Columbia Leghorns and others. It had been established by Sturtevant[3] that at least one sex-linked gene was concerned in the production of the patterns of Columbian Wyandottes.

Reciprocal crosses were made between standard bred Light Brahmas and Buff Orpingtons. The first generation males from the reciprocal crosses were alike. They were Columbian pattern birds (Figs. 13 and 14) with clear white body plumage, but with less black in the wings, tails, and hackles than appeared in the Columbian parents. The first generation females (Fig. 13) sired by the Columbian male were likewise of the Columbian type with reduced black. The first generation females out of the cross of Columbian female by buff male were buff in color (Fig. 13), but like the first generation Columbian chicks they developed black pigment in wings, tails and hackles.

[1] Contributions in Genetics No. 17.
[2] Dunn, L. C. *American Naturalist*, LVI:242-255. 1922.
[3] Sturtevant, A. H. *Journal of Experimental Zoology*, XII:499-518. 1912.

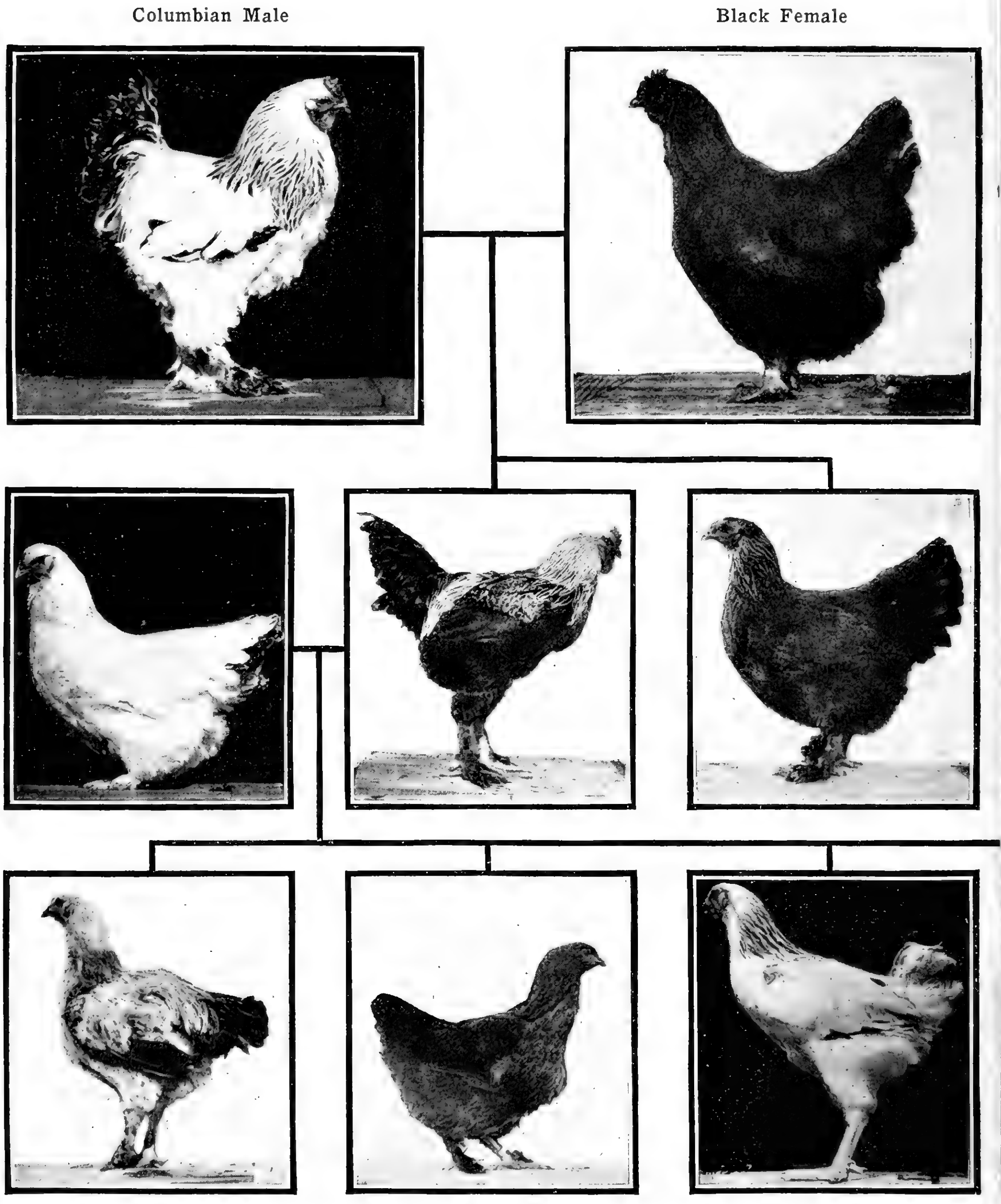


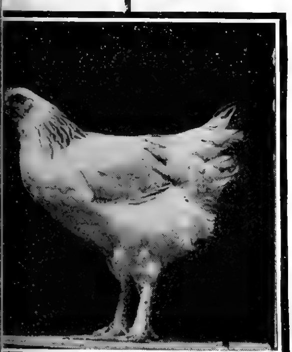
CHART SHOWING COLOR INHERITANCE IN CROSS OF BLACK

FIGURE 12. In the first generation the males are of the Duckwing type, the females of the with Columbian female, three types of plumage color are encountered: Duckwing males and Bir always females. In the reciprocal cross of black male by Columbian female all males were of the father. Thus in this cross is found the same type of sex-linked inheritance found in the Buff-Colur

The numbers of chicks produced by these crosses are given in Table 1. It is at once apparent that as regards the difference between buff and white ground color the reciprocal crosses give different results. Columbian is transmitted by the Light Brahma male to both sons and daughters and is almost completely dominant. Columbian females, however, transmit the character only to their sons; their daughters are buff like the father. The first generation Columbian females when backcrossed to pure buff males produced approximately equal numbers of buff and Columbian chicks. All of the buffs were females and all of the Columbians were males. The first generation Columbian males bred to buff females, on the other hand, produced equal numbers of buff males and females and Columbian males and females. The buffs extracted from these backcrosses when bred *inter-se* produced only buff chicks of both sexes. These results indicate that the white Columbian coloration is due to a single dominant sex-linked gene, (called Silver), the recessive allelomorph of which is buff. The gene for silver when present singly in the zygote, apparently prevents the development of buff pigment in the plumage, as Sturtevant and Punnett have concluded from other cases.

The other heredity (as far as it concerns plumage color) of the Columbians and buffs used by us is apparently very similar, with the exception that these two varieties differed also in the extent to which black was developed in the feathers of the wing, hackle and tail. The Columbians had much black in these parts; the buffs had almost none, while the hybrids had an intermediate amount. Later generations showed that factors governing the amount of black pigment were transmitted independently of sex and of the ground color of the plumage. These "darkening" modifiers were probably numerous in the Columbian and few in the pure buff type. (See Fig. 15 showing variations in amount of black in the wings and tails of both Columbian and buff types.)

From these experiments it appeared that the Columbian and buff colorations differed in one gene determining the presence or absence of buff in the plumage, and also represented two stages in the development of black in the plumage. The localization of black was similar in the two varieties, being restricted in each type to the feathers of the wing, hackle and tail.



Columbian Female

Buff Female

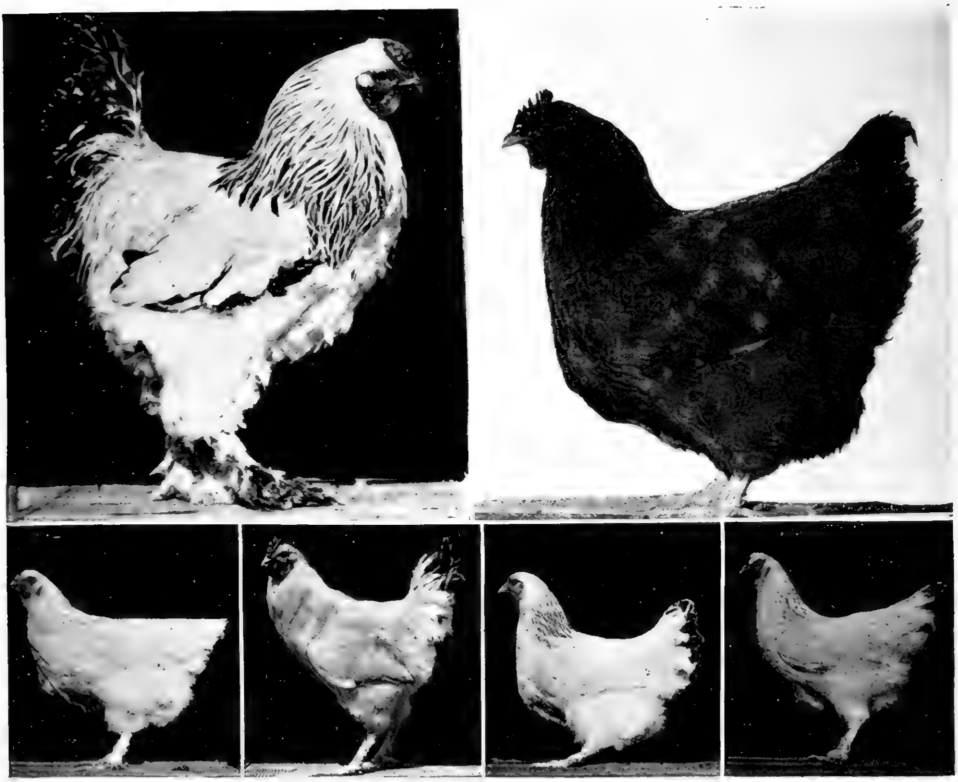
COLUMBIAN AND BACKCROSS

n. In the backcross of the first generation Duckwing male emales, Columbian males and females, and a new type, buff, wing type, but the females were unmarked black like their cross (Figures 13 and 14).

Columbian and Black

Further experiments were undertaken to study the expression of the silver gene when introduced into fowls in which much black pigment was present, as in self-black varieties. We hoped also to learn something of the genetic constitution of the blacks with regard to the presence or absence of the silver gene and to study the transmission of the pattern in which black is restricted to the wings and tail.

Reciprocal crosses were made between Light Brahmas as the Columbian pattern parents, and



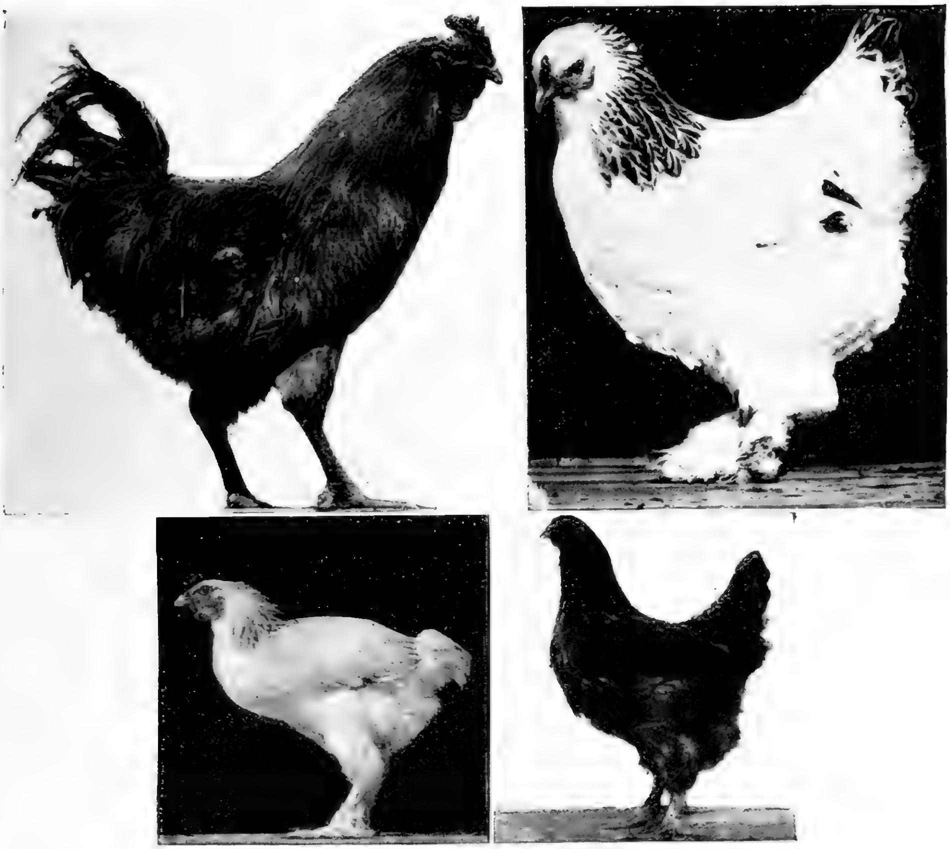
SEX LINKED INHERITANCE IN BIRDS

FIGURE 13. In the cross between Columbian male and Buff female, both sexes of the first generation are Columbian. In the reciprocal cross this is not the case, only the males are Columbian, the females being buff like their father. Further breeding experiments prove these females to be entirely free from the Columbian color factor, and to be genetically pure buffs. This type of sex-linked inheritance, found in moths, butterflies, and birds, is known technically as "WZ" inheritance to distinguish it from the "XY" type of inheritance found in man, and in the fruit fly, where it has been most intensively studied.

several self-black fowls, chiefly pure bred Black Orpingtons (Fig. 12), although a few self-blacks extracted from a previous cross of Light Brahma by White Leghorn were included. In the first generation the reciprocal crosses yielded dissimilar results. Columbian male by black female produced all black chicks (see Table 2). As adults the males and females from this cross were quite similar aside from secondary sexual differences in pattern.[4] They were black with much white lacing appearing in the hackles, saddles, and wing bows of the males (Fig. 12). These males have been classified as Silver Duckwings, since they resemble that plumage type. The females were likewise black with white lacing on the feathers of head, neck and breast, as in the Birchen pattern (Fig. 12). The appearance of sexual dimorphism in

[4] All of the females from this cross died before the adult plumage was fully developed. It is assumed that their adult pattern would have been similar to that of the black daughters of F_1 Black ♀ × Columbian ♂ (cross 7 Table 2).

Buff Male — Columbian Female



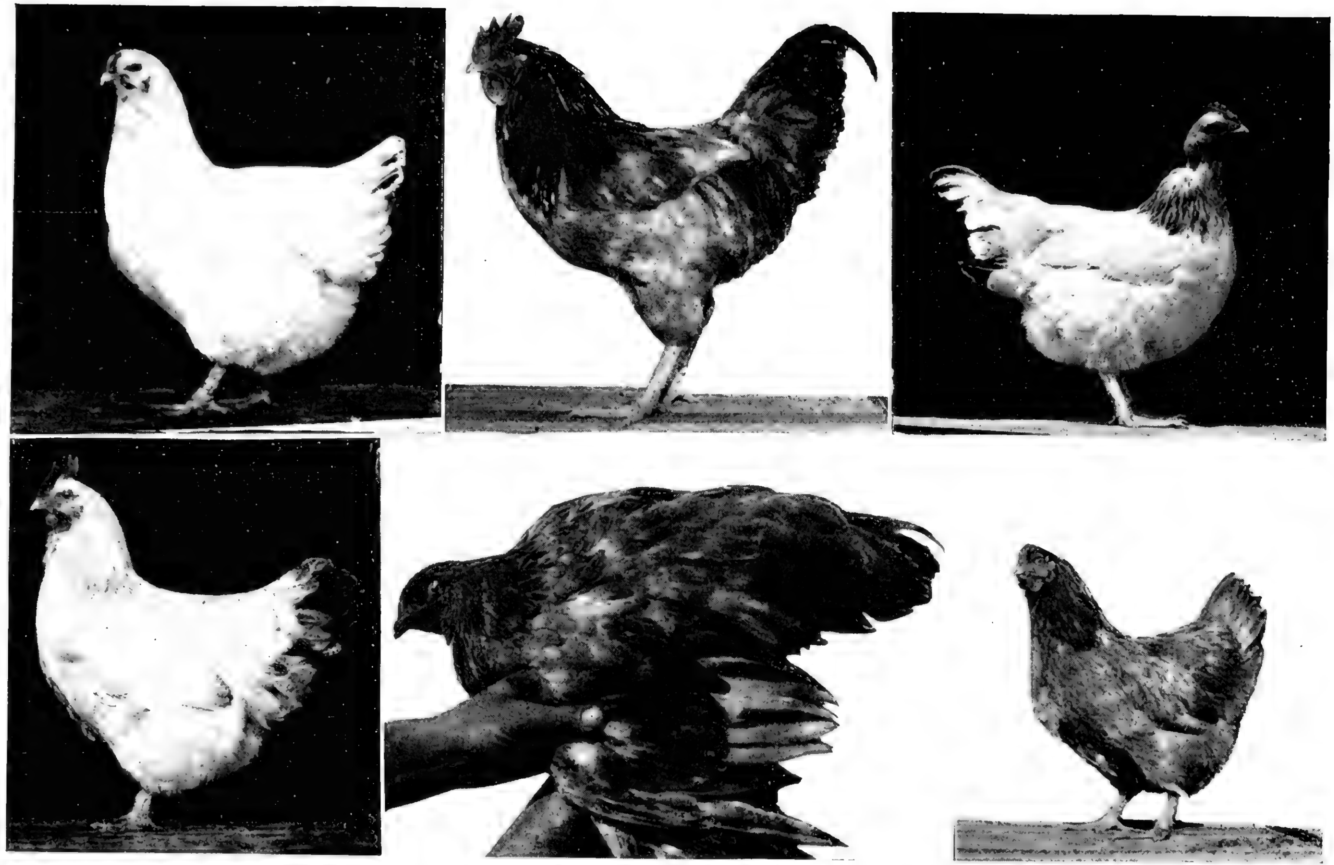
Columbian Male — Buff Female

THE RECIPROCAL CROSS

FIGURE 14. When the male is buff and the female Columbian all females of the first generation are buff, while the males are Columbian like their mother. This mode of sex-linked inheritance is explained by assuming that there are two distinct sex-determiners located in the W-chromosome and the Z-chromosome respectively. The W-chromosome has not been shown to carry any other factors than those determining sex. Two Z-chromosomes produce a male, a W- and a Z-chromosome produce a female. That is, all individuals that carry a W-chromosome are females. Therefore the W-chromosome is inherited in the maternal line only. The other sex-determiner must come from the male parent, carrying with it his typical color factor. Thus even though buff is recessive to Columbian, all females of the first generation of this cross are buff, because that is the only color determiner present in the first generation females.

the offspring of this cross was interesting since in both parent varieties the males and females are alike in color and pattern.

The reciprocal cross of Columbian female by black male produced likewise all black chicks. As adults the males were similar to the sons of the first cross described, i. e., black with white in hackle, bow, and saddle in a pattern approximating that of the Dark Brahma or Silver Duckwing. The females from this cross were self black. One of them showed a few red-bordered feathers under the lower jaw. There was no appearance of silvering in the plumage nor any development of pattern.



SECOND GENERATION OF THE BUFF BY COLUMBIAN CROSS

FIGURE 15. The amount of black pigment varies greatly in the second generation. Further experiments showed that the factors producing these black markings are inherited independently of sex, and of the ground-color of the plumage. In the Columbian and buff varieties the distribution of black is limited to wings, hackle, and tail.

The first generation Duckwing males were backcrossed with Columbian females (Fig. 12) and were also tested by crossing with buff females. The results are given in Table 2, crosses 4 and 5. By the Columbian females these males produced equal numbers of black and non-black chicks (40:39); while of the non-black chicks thirty-three were Columbian and six were buff. Of the buffs four lived and proved to be females, while two which died young were dissected and also found to be females. Both sexes were present in the black and Columbian classes. By the buff females the first generation males produced also approximately equal numbers of black and non-black chicks (19:22). Of the non-black chicks approximately half were Columbian and half were buff. The sexes were equally represented in all classes.

It is plain from these facts that a single factor affecting the development of black pigment differentiates the black from the Columbian coloration. The factor for self-black or extension is dominant over its recessive allelomorph in the Columbian type in which black develops to a limited extent in the wing, hackle, and tail feathers. Segregation takes place in the gametes of the first generation male, and when crossed with a non-extended type, black (extended) and non-black (restricted) chicks appear in a normal monohybrid ratio. However, an additional factorial difference between black and Columbian is necessary to explain the dissimilarity in the adult patterns of the hybrids from reciprocal crosses, and the appearance of a new type, *buff*, when the hybrid males are crossed with the Columbian parent. This difference is apparently the same as that which distinguishes buffs from Columbians. The Columbian males transmit the gene for silver or inhibition of buff to both sons and daughters and even in the presence of extended black this gene is able to express itself in the silvering which appears in both sexes from this cross. The Columbian female transmits it (as we have found above) only to her sons; and these in the crosses with black are silvered in the Duckwing pattern; while her daughters never receive it and are self-black like their father. Moreover, when the first generation Duckwing males are bred to Columbian females we should expect that a certain number of offspring should receive neither silvering nor extension. Since the Columbian female transmits silvering to all sons, but never to daughters, while the first generation Duckwing male transmits it to half of his sons and half of his daughters we should expect that the only individuals not receiving silver from this source should be females. It was found that all buffs resulting from this cross were females and this is undoubtedly the double recessive class showing neither extension nor silvering. The genotypes of parents and the numbers of progeny produced on these assumptions should be as follows:

Let E^m = Extension of black to all parts of plumage.

Let e^m = Restriction of black to wings, tail, etc. (Buff or Columbian.)

Let S = Silvered (Columbian, Duckwing, etc.).

Let s = Not silvered (Buff).

— denotes the W chromosome of the female which has not yet been found to carry any factors.

	Black ♀ E^mE^ms—	×		Columbian ♂ e^me^mSS	
	Columbian ♀ e^me^mS— × Duckwing ♂ E^me^mSs				Birchen ♀ e^me^mS—
Genotypes	E^me^mSS E^me^mSs	E^me^mS— E^me^ms—	e^me^mSS e^me^mSs	E^me^mS—	e^me^ms—
Adult Colors:	Duckwing ♂	Birchen ♀	Columbian ♂	Columbian ♀	Buff ♀
Down Colors:	Black		Columbian		Buff
Ratio:	4		3		1

A photographic chart showing these crosses given in Figure 12.

The number of chicks expected from this cross on the above assumption compared with the number obtained is given below:

	Black	Columbian	Buff
	♂ & ♀	♂ & ♀	♀
Obtained........	40	33	6
Expected........	39	30	10

The agreement of the actual results with those expected is good, if one excepts a slight deficiency of buffs and a slight excess of Columbians. With the small numbers involved these departures are not serious.

When the first generation Duckwing male is crossed with buff (double recessive) females equal numbers of all classes of chicks should appear. The results compared with this expectation follow:

	Black	Columbian	Buff
	♂ & ♀	♂ & ♀	♀
Obtained........	19	12	10
Expected........	20	10	10

The first generation black females (from Columbian ♀ x black ♂) were crossed with Columbian and with buff males. On our hypothesis they should be heterozygous in extension and should not transmit the gene for silver. The results are given in Table 2, crosses 7 and 8. By a Columbian male they produced equal numbers of black and Columbian chicks of both sexes; (15:14) by a buff male they produced equal numbers of black and buff chicks of both sexes (16:13):

Finally, the first generation Birchen females were tested by crossing with Columbian and with buff males (Table 2, crosses 2 and 3). By hypothesis they should transmit extension to half their progeny and silvering to their sons only. All daughters should be buff or black carrying buff. The cross with the buff male is here the critical test.

From this cross resulted the following:

	Black (silv'd)	Black (non-silv'd)		Columbian	Buff	
	♂	♀	sex?	sex?	♀	sex?
Obtained	3	2	2	2	4	2
Expected	3	4		4♂	4	

No exceptions to expectation were found and the agreement is as good as could be expected with such small numbers.

Considering all of the crosses together, it is found that all support the hypothesis proposed, as far as down color of chicks is concerned. The cross of extended black × restricted gave in the first generation thirty-two extended. The backcross of the first hybrid generation with restricted (buff or Columbian) gave ninety-nine extended and ninety-eight restricted—equality expected. Extended black appeared to be completely dominant to restriction and completely epistatic to silver in the down pattern. The segregation of silver and buff must then be measured in the restricted classes of chicks and here the crosses of all heterozygous Columbians bred *inter-se* or crossed with buff produced a total of forty-seven Columbian and twenty-two buff, as compared with forty-four Columbian and twenty-five buff expected. Silver in all cases segregated as a sex-linked character dominant over buff.

Due to a high mortality from an epidemic disease, many of the backcross chicks recorded did not live to develop adult plumage. Those which did survive are recorded under "adult colors" in Table 2. All of the black chicks as adults developed plumage in which black was extended to other parts of the plumage in addition to wings, tails, and hackles, while the buff and Columbian chicks developed adult plumage in which black was restricted to wing, tail, and hackle. The amount of black in these parts was variable. In some chicks from the backcross with Columbian, the Columbian pattern segregated in its original form (Fig. 12) both on silver and buff ground colors; while some were ob-

served with as little black in these parts as the original buff parents. None was found outside the range of darkness of pure Columbian fowls. The cross with black cannot be said, therefore, to have had any darkening effect on the Columbian pattern.

Among the extended offspring there was considerable variation in the amount of black in the plumage, although there was no overlapping between the extended and restricted classes. The colors found diluting black, or appearing in a pattern on a black ground were either silver (white) or buff (Fig. 12, bottom row), although in some cases, particularly among the males, it was very hard to tell whether the extra color was white or buff. These doubtful cases were birds with extremely light straw or cream markings which were continuously variable with the pure white and buff marked classes. No self (unmarked) blacks were recovered. Such birds were expected from crosses 3, 4, 5 and 8. The fact that no fowls hatched from the backcross with Columbian or with buff would be pure for extension (E^mE^m) might be expected to account for the absence of pure black segregates were it not for the fact that the females from cross 6 Columbian ♀ × Black ♂) are known to have been heterozygous in extension (E^me^ms—) and yet to have developed self black plumage. The paucity of numbers or the contribution of pattern factors by the later buffs and Columbians used may account for the non-appearance of blacks. The present evidence is not critical.

The patterns in which the white or buff pigments appeared on the black ground-color of the extended backcross female chicks were various, although most of them could be referred to the general class of penciling as it appears in the Partridge or Dark Brahma pattern, concentric lines of light color on a dark ground, following roughly the contour of the feather. In pattern the females varied from the Birchen type with light color only on the head, neck and upper breast (Fig. 12) to a light Dark Brahma or Partridge type. In the males the light pigments appeared principally on the feathers of the hackle, saddle, and wing bow, either as lacing, or as a color occupying the whole feather.

Most of the males could be classified as Silver or Buff Duckwings. Here, as in the females, there was evidence of considerable variation in the amount of black pigment present in the body feathers, and it appeared that in addition to a main factor governing the extension of black to all parts there were minor factors regulating the depth of saturation of the black pigment. In the juvenile plumage some males showed evidences of the female type of penciling. This was never present in adult male plumage with the exception of the markings on the breast feathers of some very light males. The Duckwing pattern is the male equivalent of the partridge or penciled pattern in the female and appears in the males of such varieties as the Dark Brahma or Partridge Plymouth Rocks. The absence of pencilling in the males probably constitutes a secondary sexual or sex-limited difference, dependent on the presence of testicular hormone or the absence of an ovarian secretion. Some of the backcross Duckwing males might, therefore, be expected to transmit pencilling. No progeny tests or castration experiments have yet been completed as a test of this supposition.

Concerning the source of the penciling which appeared in the backcross females we have no exact information. It may have been present in the black parents, which lacked the buff or silver pigment needed to fill the pattern; or as is more probable it may have been present in the Columbian parent, but unable to express itself in the absence of the extension factor. Light Brahma (Columbian) fowls are sometimes seen which have more than the usual amount of black pigment in the under-

color of the feathers on the back. This black occasionally "shows through" on the surface and is often found to be arranged in an imperfectly pencilled or mossy pattern.

Summary and Conclusions

The buff and Columbian colorations of fowls differ in one principal gene determining the presence or absence of buff in the plumage and probably in multiple factors determining the amount of black developed in wing, tail, and hackle feathers.

Buff and Columbian differ from black by a gene determining the restriction of black to hackle, tail, and wing. Its dominant allelomorph, which is present in self black, determines the extension of black to all parts of the plumage.

Black fowls are genetically buffs with the extension factor superposed. When the gene for silver is present in a black or "extended" fowl it "shows through" in a pattern determined possibly in part by the residual heredity of the black, or by pattern factors contributed by another variety. The appearance of fowls which have both extension and silver make it seem probable the the Dark Brahma variety will be found to be of the genotype E^mE^mSS.

Although in the present types, black and Columbian, the plumage is alike in both sexes, in the first and later generations sexual dimorphism appeared in the dark (extended) fowls. This may possibly be traced to a recombination of pattern and extension factors, which reacts to the sexual hormones in a manner different from either parental combination.

The origin of the three colorations considered is not certainly known. Genetic and historical evidence indicates that the buff and Columbian colorations may have diverged by a single gene mutation. Extended black varieties probably antedate the restricted types, and it is probable that the latter arose from the former by a mutation in the extension factor.

TABLE I. *Crosses of Buff and Columbian Fowls.*

Cross No.	Generation	Parents	Down Colors of Chicks: Buff	Down Colors of Chicks: Columbian	Adult Colors and Sex: Buff ♂	Buff ♀	Columbian ♂	Columbian ♀
1	P_1	Buff ♀ × Columbian ♂	..	37	..	..	9	8
2	BC	F_1 Columbian ♀ × Buff ♂	34	36	..	21	13	..
3	BC F_1	BC Buff ♀ × BC Buff ♂	83	..	17	15	..	..
4	P_1	Columbian ♀ × Buff ♂	14	13	..	8	12	..
5	BC	Buff ♀ × F_1 Columbian	10	13	3	6	6	6

TABLE II. *Crosses of Black and Columbian Fowls.*

Cross No.	Parents	Down Colors of Chicks: Black	Columbian	Buff	Adult Colors and Sex — Extended Black: Duckwing ♂ white	Duckwing ♂ buff	Black ♀	Birchen ♀ white	Birchen ♀ buff	Restricted Black: Columbian ♂	Columbian ♀	Buff ♂	Buff ♀
1	Black ♀ × Columbian ♂	17	..	..	2	..	..	..	..	..	..	..	..
2	F_1 ♀[a] × Columbian ♂	2	2	..	..	..	..	..	..	..	..	..	..
3	F_1 ♀[a] × Buff ♂	7	2	6	1	..	..	..	..	..	..	..	2
4	F_1 ♂ × Columbian ♀	40	33	6	4	..	..	3	3	7	5	..	4
5	F_1 ♂ × Buff ♀	19	12	10	2	2	..	2	2	1	2	5	2
6	Columbian ♀ × Black ♂	15	..	..	3	..	6	..	..	..	..	..	..
7	F_1 Black ♀ ♂ Columbian ♂	15	14	..	5	..	..	3	..	..	..	..	..
8	F_1 Black ♀ × Buff ♂	16	..	13	..	4	..	..	3	..	..	2	1

NOTE—The classes "white" and "buff," under Duckwing males and Birchen females, refer to the color of the markings on necks, hackles, and wings.

PARENTHOOD AND RACE CULTURE[1]

PERCY W. TOOMBS
Memphis, Tenn.

WHEN the founders of this republic first set down the tenets upon which they proposed to establish a new state they declared that all men are born free and equal. This may almost be said to be their basic principle, the cornerstone upon which their entire plan of government was founded, and in general it is the principle upon which most of our laws and a considerable part of our social code has been based. We have never—as a nation—seriously questioned the truth of this assertion, nor gone to any trouble to find out whether its application tended to good or evil results. It was the special pride of those who had a hand in the original formation of the civil and social regulations which still govern these United States that no account was made of caste, that family, birth, breeding, played no part in the assignment of honor or prestige, that every citizen had full chance to rise by merit alone and that all prizes could be gained by those who would reach out and take them.

It is only within the memory of practically every person in this room that anyone seriously questioned the natural equality of all races of mankind. Every man was held responsible for his conduct, which must be regulated according to the code most generally acceptable to his fellows; failure to conduct himself according to this code was visited with punishment. It was admitted that some individuals had less opportunity than certain others to learn and understand this code, and a degree of leniency from society was extended to them on that account, but in general it was taken for granted that those whose conduct ran contrary to the best interests of society erred because they were unwilling—not because they were unable—to act in accordance with generally accepted standards of right and morality.

Environment Overemphasized

During the last quarter century especially, there has been a world-wide impulse toward social betterment and race improvement. Many of those who talked most and labored hardest over these movements did not have a very clear idea of just what they were aiming at. The general idea was that even if nature has imposed certain handicaps upon the individual at birth, these impediments can be removed by proper care of the body and intelligent training of the mind, and that any individual so relieved of his congenital deterrents can in turn pass on to his descendants the physical and mental improvements which his environment has made in him, at the same time failing to transmit to them the undesirable qualities with which he was originally equipped. Thus in the course of a few generations even a heavily handicapped individual might exhibit progeny free from all taint. Of course it was recognized that this was an ideal, not likely to be immediately attained, but it was not doubted that it was at least theoretically possible. It is on this assumption that most of our present system of charities and correction is based. Where the most glaring congenital inequalities have presented themselves—as in the case of the negro—we have endeavored to level them by federal statute, believing that the new doctrine that no man should suffer degradation because

[1] Read before the Memphis Chapter of *The Egyptians,* April 11, 1922.

of race, color, or previous condition of servitude, could completely obliterate the old dictum that the leopard cannot change his spots, nor the Ethiopian his skin.

Recently, however, certain students and investigators began to doubt the possibility of the "transmission of acquired characteristics" which is the scientific statement of the assumption which we have just been considering. As far back as 1869 there had been published in England a book by Francis Galton concerning the Heredity of Genius. This book attracted very little attention at the time it was published, probably because a near relative of Galton's—Charles Darwin by name—had turned scientific attention into other channels and aroused discussion of the Descent of Man, the Survival of the Fittest, and other lines of thought which laid special emphasis upon the effect of environment upon the individual and the race. A new edition of Galton's book was published in 1914, and in the forty-five years which elapsed between the appearance of these two editions has grown up what we now term the science of eugenics.

Eugenics is the science of the improvement of the human race by better breeding, or, as Galton himself has put it, "The science which deals with all the influences that improve the inborn qualities of a race." Eugenics, then, relates to parenthood, primarily, and to marriage secondarily, in that from the eugenic standpoint the success or failure of a marriage can be measured solely "by the number of disease-resistant cultivable offspring that come from it." With the environment, the relation of parents to children after they have been born into the world, the relation of these children to human society as a whole or to the particular objects with which they are surrounded, it has nothing whatever to do.

With "social betterment," as we are in the habit of using the term, it has no connection. It assumes that the only way in which the race can be bettered is by improving the breed, not by improving the conditions which surround those who are already bred; it relates—to employ once more the phraseology of Galton—to *nature* and not to *nurture*.

The arguments which the eugenists have employed to prove their contention that the nature of man is inherent and cannot be altered by conditions of environment are much too extended to be considered in an address of this sort, so I must content myself with calling to your attention some few of the most common demonstrations which are used to make clear the position which the promoters of this science occupy. The arguments against this point of view are much more familiar to the general public, for the emphasis has been laid on environment in practically all the activities of charity organizations, social betterment movements, labor union agitation and other propaganda which have been offered to the public at large. In regard to eugenics there are very general and very serious misconceptions, many quite well-informed persons believing that eugenists aim at the elimination of the unfit, something after the manner of the ancient Spartans who destroyed all defectives who were born into their state in order that their stock should be uniformly rugged and intelligent.

We learn from H. E. Jordan that it is not now so common to attribute the fall of Rome to degeneracy following luxury and over-culture, as Gibbon tried to demonstrate, or to a malarial parasite, as urged by Dr. Ross; nor to the principle of natural racial senility which was the ingenious supposition of Prof. Ray Lankester; the more probable cause was the fact pointed out by David Starr Jordan, that the human harvest was bad; that Rome sacrificed her best manhood in war and left the business of breeding new generations to weaklings, cowards, and scullions. This is exactly the situation

which the great European nations face today. While our loss in the war just past was in no wise comparable to theirs, the same problem is present in this country, because there is a constant tendency toward relative and absolute sterility among that class of society which is best fitted to produce the next generation, and the most prolific are the less fit to carry on the torch of our civilization.

The scientific basis upon which a remedy for national death, "race suicide," as Theodore Roosevelt so often reminded us, rests upon our knowledge of heredity. An understanding of the mechanism of the inheritance of physical characteristics is necessary if we are to comprehend the foundation upon which the science of eugenics rests.

When we begin to apply the principles of heredity to mental peculiarities we enter upon a subject of practically unlimited extent. Take for example, feeblemindedness, which has been extensively studied by Dr. Goddard, head of the training school for such unfortunates, at Vineland, New Jersey. By repeated tests and observations he has demonstrated that when both parents are feeble-minded all of the children will also be so; but if one parent be normal and of normal ancestry, all of the children may be normal; whereas if the normal mate have defective germ cells, one-half of his progeny by a feeble-minded woman will be defective. It has been noted that feeble-mindedness and epilepsy often replace each other in a family pedigree.

Rosanoff has demonstrated that if both parents are the victims of maniac depressive insanity or of dementia precox, their entire family will be neuropathic, but if one parent only comes from weak stock and if affected, only half of the children are liable to go insane; and lastly, that such "nervous breakdowns" do not occur in families where both parents are sound and from untainted stock.

Fallacy of "The Melting Pot"

The principal fact to be drawn from the most recent and exact scientific investigations is that the blending of family or racial traits does not take place, and the "melting-pot" in which men of every nation under heaven could be converted into a homogeneous nation is naught but a phantom of the imagination. It has been proved that unit characters do not blend and after many generations a certain given characteristic may crop out all uninfluenced by repeated unions with foreign germplasms. This forces us to the conclusion that the influence of the individual on the race is a thing of prime importance, and the responsibility of every potential parent looms full of significance to all his fellow citizens. The chance of being "lost in the crowd" becomes relatively much smaller.

Galton's first studies were made particularly to show that heredity had much more influence than environment in determining traits of character, and he devoted his attention especially to that complex of desirable mental characteristics which we term *genius*. One study was upon Fellows of the Royal Society which usually lists among its members most of the eminent scientists of the British nation. Galton assumed that at least one per cent of such a membership might reasonably be expected to be "noteworthy." As a rule not more than one in four thousand of our population gets his name in *Who's Who*, which is only one-fortieth of one per cent. Galton's results showed that on the basis of one per cent the fellows of the Royal Society had noteworthy fathers with twenty-four times the frequency of the general population, noteworthy brothers with thirty-one times the frequency to be expected in the general population, and noteworthy grandfathers with twelve times the expected frequency. In another study of the judges of England between 1660 and 1865—a period of slightly more than two hundred years—he found that

the chance of the son of a judge to possess extraordinary ability was just about five hundred times as great as that of a boy taken at random from the general population.

Two American Families

The study of genealogy and the cultivation of family trees has for some time been a favorite hobby among a certain class of people in the United States, but "looking up your ancestors" has been regarded as a subject for jest among the great majority of our people. Some of these pedigrees, however, have a very direct bearing on the subject we are discussing. As examples I will mention the histories of two "old American families," the descendants of Elizabeth Tuttle and those of "Ada Jukes."

"'On November 19, 1667, Elizabeth Tuttle married Richard Edwards, of Hartford, Connecticut, a lawyer of high repute and great erudition. Like his wife, he was very tall, and as they walked the Hartford streets together their appearance invited the eyes and admiration of all.' In 1691 Mr. Edwards was divorced from his wife on the ground of her adultery and other immoralities. After his divorce, Mr. Edwards remarried and had five sons and a daughter by Mary Talcott, a mediocre woman, average in talent and character, and ordinary in appearance. 'None of Mary Talcott's progeny rose above mediocrity, and their descendants gained no abiding reputation.'

"Of Elizabeth Tuttle and Richard Edwards, the only son was Timothy Edwards, who graduated from Harvard college in 1691, gaining simultaneously the two degrees of bachelor of arts and master of arts—a very exceptional feat. He was pastor of the church of East Windsor, Connecticut, for fifty-nine years. Of his eleven children, the only son was Jonathan Edwards, one of the world's greatest intellects, pre-eminent as a divine and theologian, president of Princeton college. Of the descendants of Jonathan Edwards much has been written; a brief catalogue must suffice: Jonathan Edwards, Jr., president Union College; Timothy Dwight, president of Yale; Sereno Dwight Edwards, president of Hamilton College; Theodore Dwight Woolsey, for twenty-five years president of Yale College; Sarah, wife of Tapping Reeve, founder of Litchfield Law School, herself no mean lawyer; Daniel Tyler, a general of the Civil war and founder of the iron industries of Northern Alabama; Ann Maria, wife of Edward Amana Park, president of Andover Theological Seminary, herself as astute a thinker as her clerical spouse; Timothy Dwight, the second, president of Yale University from 1886 to 1898; Theodore William Dwight, founder and for thirty-three years warden of Columbia Law School; Henrietta Frances, wife of Eli Whitney, inventor of the cotton gin, who 'burning the midnight oil by the side of her ingenious husband, helped him to his enduring fame'; Merrill Edwards Gates, president of Amherst College; Catherine Maria Sedgwick, famous authoress; Charles Sedgwick Minot, authority on biology and embryology in the Harvard Medical School; Edith Kermit Carow, wife and co-worker of Theodore Roosevelt; and Winston Churchill, one of the best known of American novelists." These constitute a glorious galaxy of America's great educators, students and moral leaders of the Republic.

"Two other of the descendants of Elizabeth Tuttle, through her son, Timothy, have been purposely omitted from the foregoing catalogue because they inherited also the defects of Elizabeth's character. These two were Pierrepont Edwards, who is said to have been a tall, brilliant, acute jurist, eccentric and licentious; and Aaron Burr, Vice-President of the United States, in whom flowered the good and evil of Elizabeth Tuttle's blood.

"The remarkable qualities of Elizabeth Tuttle were in the germplasm of her four daughters also. Among their

descendants were: Robert Treat Paine, signer of the Declaration of Independence; the Fairbanks brothers, manufacturers of scales and hardware at St. Johnsbury, Vermont; the Marchioness of Donegal; Morrison R. Waite, Chief Justice of the United States; Melville M. Bigelow; Marvin Richardson Vincent, professor of Sacred Literature at Columbia University; the Marchioness of Apesteguia of Cuba; Ulysses S. Grant, and Grover Cleveland, presidents of the United States." So the germplasm which Elizabeth Tuttle received from her forbears was handed down to enrich every department of government, of learning and culture throughout the history of this nation.

Turning now to the family of "Ada Jukes," who is also known to students of eugenics as "Margaret, the mother of criminals," her actual family name being concealed for reasons which can readily be appreciated, we find that she was of Dutch ancestry, living some time after the year 1800. She was one of six sisters, and her progeny and those of two of these sisters have been exhaustively studied, first by R. S. Dugdale, and again in 1915 by A. H. Estabrook, of the Carnegie Foundation.

"We find among the males (of Ada Jukes' descendants) twelve criminals, one licentious, five paupers, one alcoholic and one unknown; none was a normal citizen. Among the females, eight were harlots, one a pauper, one a vagrant and one unknown; none was known to be reputable."

Altogether it has been estimated that the progeny of Ada and her sisters have cost the State of New York over a quarter of a million dollars up to the year 1877, and although the family has now disappeared from Ulster County, where they long had their habitat, and are scattered all over the country, their anti-social traits are still being perpetuated, though better matings have occasionally helped to produce better individual members. Popenoe remarks in a footnote that "while such marriages may be good for the Jukes family, they are bad for the nation as a whole, because they tend to scatter antisocial traits."

The consideration of such family histories as the two just given naturally leads us to ask: How can "good blood" be perpetuated and encouraged to increase? And also: Is there any way by which the breeding of paupers, criminals and mental deficients can be stopped or diminished?

The Chief Aim of Eugenics

The elimination, or at least the diminution of the unfit has come to be generally regarded as the chief aim of eugenics. This is a mistake. The emphasis should be laid rather on the desirability, more than that the vital necessity, of increasing the numbers of the fit; in other words, it is of more importance to breed abundantly from the good stock than it is to decrease the breeding of defective stock. We can mournfully reckon in dollars and cents what it has cost a certain state to maintain a race of paupers and criminals up to the number of twelve hundred or more, but who can reckon the money value which such as the Edwards family has added to our entire country? It lies within the power of every right-minded man and woman to help along the improvement of the race. Those who are not themselves fitted to add to its stock of fine specimens can aid those who are so fitted to mate properly and reproduce abundantly. George Ade has spoken somewhere of the girl who preferred "to shop around for a husband." If more opportunities were given to all young people to "shop around" and more than that to follow the Christmas slogan to "shop early," we would have better stock to breed from for more reasons than I have time to enumerate.

A few weeks ago the Fifth Avenue Coach Company, a corporation operating the motor buses in New York City, printed and distributed a pamphlet

among its employees and patrons which was of special eugenic interest, although it was not a scientific treatise, and the word "eugenics" did not occur in it. The slogan of this company is "Civility," and this pamphlet contained more than three hundred and fifty pictures of small children, sons and daughters of the company's employees, or as they termed them, the "children of civility." It is this company's unexpressed intention to ameliorate the public manners of the citizens of New York—which everyone admits leave much to be desired—by setting them an example of politeness in the persons of the company's employees who serve this public, and it proposes to rear a breed of civil people by encouraging its men to marry and raise large families, or as they put it, to "out-populate the barbarian." This idea is worthy of consideration by all thoughtful people, and is infinitely more important than the consideration of the ethics and advisability of the sterilization or segregation of the unfit, although I do not wish to be understood as in any way belittling that side of the question. The maintenance of the superiority of any race depends in the last analysis upon the number of superior individuals of which that race is composed, not in the number of inferior ones that are missing from it.

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Embryology and Heredity

KOMPENDIUM DER ENTWICKLUNGSGESCHICHTE DES MENSCHEN, mit BERUECKSICHTIGUNG DER WIRBELTIERE, by DR. L. MICHAELIS, Privatdozent an der Universitaet Berlin. Ninth edition. With 54 text figures and two plates. Pp. 160. Price, 65 cents. Leipzig, Verlag von George Thieme, 1921.

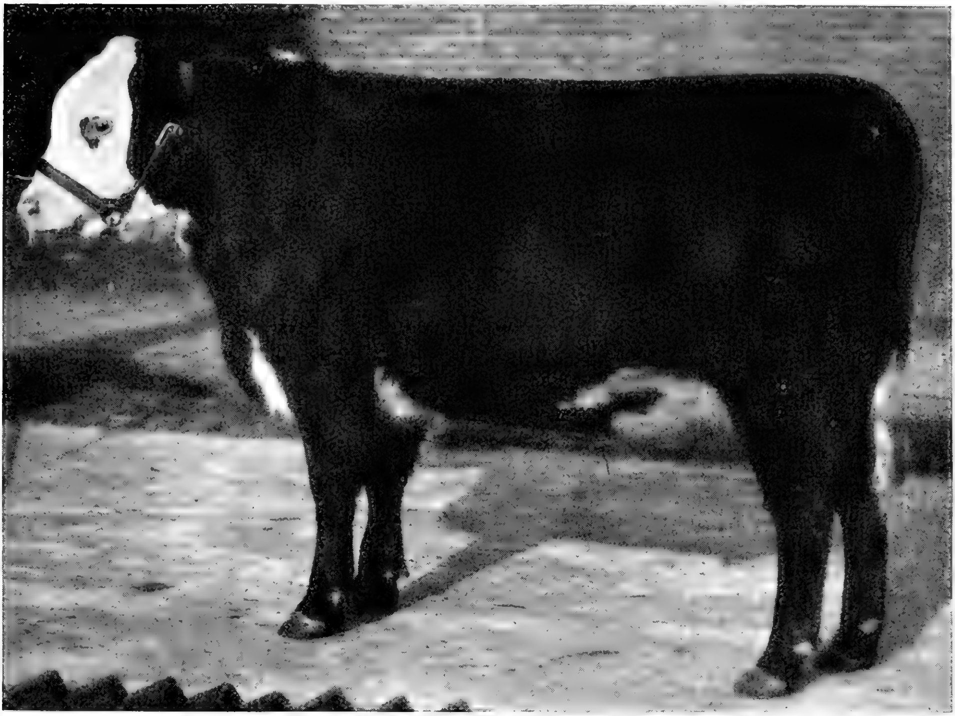
Thirty or forty years ago the study of embryology was much more popular than it is at present, when genetics and other lines of investigation have taken its place as the fashionable kinds of research. It may be that embryology had for the time being reached a point where it repaid attention less than some other branches of biology; but these other branches, and genetics in particular, have now reached a point of development where emphasis on the embryological side is highly important. All tools for the worker are welcome, and Dr. Michaelis' survey of the field is so compact yet full of material that it should be widely useful for the pocket as well as the work table.

—P. P.

UNUSUAL COLOR INHERITANCE

COAT COLOR OF CROSS-BRED STEER, QUOMAN'S PERFECTION, NOT THAT ORDINARILY ENCOUNTERED IN THE ANGUS-HEREFORD CROSS

George S. Templeton
A. and M. College, College Station, Texas



A RED ANGUS-HEREFORD BULL

Figure 16. Normally the first generation of the Angus-Hereford cross has the black body-color of the Angus and the white face of the Hereford. However, Quoman's Perfection is an exception, being red instead of black. Two other typical Angus characteristics appeared, the polled head and barrel-like body. Evidently his sire carried the red color factor as a recessive character, although this had not been indicated by thirty-nine other matings.

THE cross-bred steer, Quoman's Perfection, bred, fed, and exhibited by the Animal Husbandry Department of the A. and M. College of Texas, attracted quite a little attention at the recent American Royal and at the International Live Stock Show, not only on account of the premiums won, but because of his unusual coat color.

Quoman's Perfection won first in the senior Angus steer calf class, was reserve champion Angus steer, and a member of the first prize Angus herd of three steers at the American Royal. Two weeks later at the International, in a strong class of forty-five entries of grade and cross-bred steers, Quoman's Perfection stood second to the sensational California steer calf, and he was first prize grade Angus steer calf.

The sire of Quoman's Perfection is

the Angus bull, Quoman of Tierra Alta 248048. This bull was used for several years at the head of the College herd of Angus. During the five years that he was in service he sired thirty-five calves out of pure-bred Angus cows, one out of a grade Shorthorn, and three out of grade Jerseys. All of the thirty-nine calves sired by this bull were black. The dam of Quoman's Perfection, Belle Perfection 46th 493840, a Hereford cow, has produced four pure bred Hereford calves, all normal in color. As this cow did not "nick" well with the Hereford herd bull, and as steers were so valuable for class work, it was decided to cross breed this cow with a bull that would be more likely to "nick" with her particular type for the production of a more desirable type of steer.

On the arrival of the calf, October 28, 1921, the little fellow instead of being black bodied with white face (the color so common in this cross) was red bodied with white face. It was at first thought that there had been a mistake in the mating. By referring to the breeding records, however, it was found that the cow was mated with the Angus bull. Upon close examination of the calf it was found that he had a dark muzzle and a dark tongue which partially established the fact that his sire must be the Angus bull. As he matured the horns failed to make their appearance, a typical poll head developed, and the cylindrical turn of the body, so characteristic of the Angus, became more evident. There can be no mistake as to the steer being an Angus-Hereford hybrid. The three dominant characters usually so evident in a cross of this kind are the poll head, white face, and the black body. The first two characters named have bred true in this particular case, but how about the red color of the body coat?

Although Quoman of Tierra Alta has never sired a red calf in the thirty-nine matings referred to above, he must undoubtedly be heterozygous for coat color. In this particular mating a male gamete bearing the red color has undoubtedly fertilized the female red gamete and the calf, Quoman's Perfection, is the result of the homozygous zygote.

According to figures given in Wisconsin Experiment Station *Bulletin No.* 213, dealing with the inheritance of the red color in the black breeds of cattle, 2.61 per cent of the Angus recorded in Vols. 18 to 27 inclusive are heterozygous for red.

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A NEW METHOD OF SELF-POLLINATING CORN

Merle T. Jenkins,
U. S. Department of Agriculture, Washington, D. C.

EXTENSIVE cooperative corn breeding experiments were inaugurated at Ames, Iowa, in 1922, by the Office of Cereal Investigations, U. S. Department of Agriculture, and the Iowa Agricultural Experiment Station. It was necessary to make a large number of self-pollinations in connection with these investigations, and a modified technique has been developed that is efficient both as to time and results. Because of the interest in selection within selfed lines as a means of corn improvement and the large number of selfs that are being made each year, it seems desirable to present the modification at this time.

A method of hand-pollinating used in the Office of Cereal Investigations for some years has been as follows: The ear-shoots are bagged before any silks have appeared. After a few silks emerge, the shoot is cut back ½ to 1½ inches and the bag is replaced. In from twenty-four to forty-eight hours a good brush of silks some two inches long is ready to pollinate. The method of bagging and cutting back shoots is illustrated in Figure 17. The tassel required for any pollination may be bagged at the time of cutting back the given shoot. From twenty-four to forty-eight hours' protection from stray pollen is thus given, during which time any foreign pollen that previously had lodged upon the tassel may lose its viability.

Bags of glassine paper two and one-half inches wide and six inches long have been found convenient for bagging the shoots before pollination. As they are semi-transparent, the development of the silks may be watched and the time otherwise required to feel each shoot is saved. The size of the bags is such as to give sufficient room and yet to stay in place without fastening. Occasionally a bag is lost, but a little practice in using them reduces this loss to a minimum. Heavy twelve-pound paper bags have been used for the tassels in selfing and the same bag is used to protect the shoot after pollination.

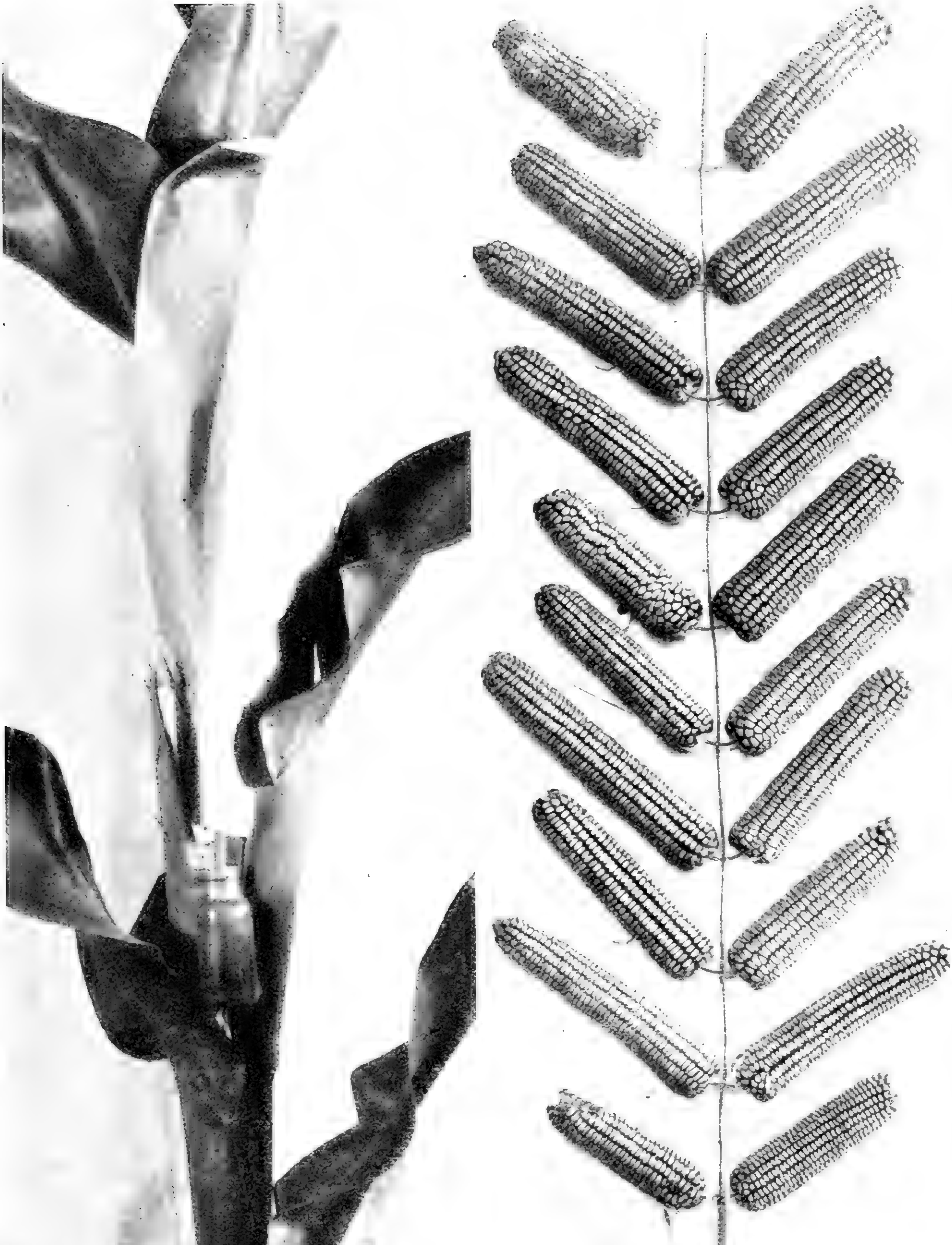
The method used in 1922 was similar to this up to the time of cutting back the shoots. At this time the tassel was pulled, shaken to free it from foreign pollen, and enclosed with the shoot in a twelve-pound bag. In order to keep the tassel shedding, its stem was inserted into a small bottle of water that had been attached to the stalk.

It was found desirable to have two men operate together. One carries tags for labeling the ears and a pail of water containing a supply of small, wide-mouthed bottles. Operating from the side of the plant bearing the ear-shoot he first fastens a tag just above the ear-bearing node, and then fastens one of the small bottles of water to the stalk just above the tag. The tag should be to his right and the bottle to his left as he faces the plant.

The other man carries a supply of twelve-pound paper bags, paper clips or string, and a knife. Operating from the opposite side of the plant, he pulls the tassel, frees it from pollen by shaking, and puts it into one of the bags. He then removes the glassine bag, cuts back the shoot, and places the bag containing the tassel over the shoot, inserting the stem of the tassel into the bottle of water. The stem should be kept to the back of the bag (away from the stalk) and to the right for convenience in handling.

TECHNIQUE OF THE NEW METHOD

FIGURE 17. Before the silks appear a glassine bag is placed over the ear. After the silks are visible the end of the husk is cut back, and the tassel of the plant is removed and shaken to free it from foreign pollen. Then a twelve-pound paper bag is slipped over both tassel and ear and fastened in place. The stalk of the tassel rests in a small bottle of water to prevent it from withering before a considerable quantity of pollen has been shed.



POLLINATION COMPLETED—TYPE OF EARS OBTAINED

FIGURE 18. The advantages claimed for this method of self-pollinating corn are that it prevents danger of contamination and that the ears produced are well filled from base to tip. About forty-five pollinations an hour can be made by two men. The method does not lend itself well to cross-pollenation, but by using individual branches of the tassel a useful modification might be developed.

During this operation he is assisted by the first man, who holds the leaf away so that the bag may be pulled well down over the shoot. The bag then is fastened in place.

The bag may be tied in place with string or wire, or may be fastened with paper clips by bringing the two front corners of the bag (toward the plant) forward around the stalk, folding them, and clipping. This method is shown in Figure 18, which illustrates a plant on which pollination has been completed. The use of clips has several advantages. The corners of the bag not clipped accommodate the growth of the shoot so that little further attention is required. There also is less damage from rain, as the attachment to the stalk helps to hold the ear erect with the bag over it like a tent.

The time required for the operation as described is about the same as would be needed to apply pollen from the previously bagged tassel under the older method. Consequently the time otherwise required for bagging the tassel is saved. Two men made 380 pollinations in six hours, under favorable conditions during the past season. This is something more than sixty per hour or one pollination per minute. The average, however, was about forty-five pollinations per hour for two men.

Pollinations may be made at any time of the day, as shedding of pollen does not have to be in progress at the time of bagging. It is necessary, however, to know that the tassel will shed pollen later on. In this connection, it has been found that tassels will shed little or no pollen if they are pulled more than a few hours before shedding begins. If pulled after the central spike has begun to shed abundantly they may continue to shed for four or five days under favorable conditions, and this is the best time to pull them.

Bottles of about one ounce capacity with a mouth about three-quarters of an inch in diameter proved the most satisfactory of several kinds tried. These were obtained at prices ranging from two to three cents each. They were left on the stalks about four days and then were collected for further use, so that only enough were needed to take care of four or five days' pollinations. Some tassels will shed satisfactorily without being put in water. The cost of the bottles is small, however, and it is safer to use them in all cases. The bottles may be attached to the stalk with copper wire (about No. 23 B&S) twisted first around the neck of the bottle and then about the stalk. The bottles also may be hooked in place by means of a stiff wire fastened to the neck and properly bent.

This method was used satisfactorily in making over 7,000 self-pollinations in 1922. A representative sample of the ears obtained is shown in Figure 18. Both yellow and white varieties of corn were grown in the pollinating plat and were shedding pollen at the same time, so that if much contamination had occurred some of it should be apparent as xenia. Most of the ears have now been shelled and very few cases of contamination have been observed. It seems likely, moreover, that there is at least as little danger of contamination in using this method as there is in any method that involves even the briefest exposure of receptive silks to a pollen-filled atmosphere.

The method can be utilized in cross pollination when it is not necessary to use the tassel more than once. It also may be possible to use only individual branches of a tassel so that several pollinations can be made from a single plant. This seems worth trying because of the safety of the method, in spite of the fact that it does not lend itself as well to the less routine operation of crossing. In self-pollination, however, the method is not only safe but efficient.

MUTATIONS OF THE POTATO

TWO SOMEWHAT UNSTABLE LEAF-FORM SPORTS OF THE IRISH POTATO

DONALD FOLSOM
Maine Agricultural Experiment Station, Orono

MUTANT AND NORMAL LEAVES

FIGURE 19. While greater variation is to be expected in the progeny of plants that reproduce by seed, the breeder of those that are propagated vegetatively also has an opportunity to take advantage of variation, in the form of bud sports. Frequency of sporting varies greatly in different species; in the study here reported only five leaf-form mutations were observed in more than 350,000 plants examined. The leaves shown above are both from the same plant, the fifth vegetative generation of a thick-leaved mutant discovered in the Green Mountain variety. The leaf on the right is typical of the mutant form, while the other has partly reverted to the normal.

VARIEGATION sports of the Irish potato have been reported by Quanjer[4]* and by Hungerford,[2] and have been observed by the writer. MacKelvie[3] has described a sport with simultaneous loss of tuber-skin color, change of sprout color, and decrease in abruptness of tapering of the distal ends of the leaflets. Leaf-form sports appear to be infrequent in potatoes. The two types reported here seem to be somatic mutations in

*For numbered references, see Literature Cited at end of article.

A SIMPLE-LEAVED VARIATION

FIGURE 20. This plant represents the second vegetative generation of a simple-leaved strain discovered in the White Mountain variety in 1920. A tuber of this plant gave rise to the plant shown in Figure 21, the leaves of which were partly of the normal form, but the vegetative progeny of the latter were all simple leaved.

PARTLY REVERTED

FIGURE 21. This plant was raised from a tuber of the simple-leaved plant shown in Figure 20. Two of its leaves were half simple and half compound, but the plants raised from it were all simple-leaved. The fact that these plants partly revert to the normal after two generations of abnormality precludes the possibility of their unusual leaves being due to "degeneration disease." From this there is no recovery as long as vegetative propagation is continued.

a clonal variety, and have been unstable enough to revert in part to the varietal norm. The five cases to be described were the only ones noticed in over 350,000 plants observed for foliage diseases.

A simple-leaf sport of the Green Mountain variety came under the writer's observation in northeastern Maine in 1920 as a single hill in a commercial field. The second, third and fourth generations* were grown respectively in the greenhouse at Orono the following winter (Fig. 20), in the field in the summer of 1921, and in the field in 1922. The third generation (consisting of a one-stalked plant) apparently reverted partly to a compound-leaf condition, two leaves being divided longitudinally so that each was half simple-leaf and half compound-leaf (Fig. 21), but its five tubers produced

*The *generations* referred to in this paper are vegetative ones and not sexual generations.—Editor.

ten plants that were simple-leaf throughout.

Four thick-leaf sports have been observed by the writer in four different Maine fields, three in the Green Mountain variety and one in the Ehnola variety. Only one will be described here. It originated in a Green Mountain hill-selection strain grown and observed for foliage diseases from 1915 to 1920, inclusive. This hill-selection strain produced only one thick-leaf sport, as one hill in a total of 158 grown in 1918. The original thick-leaf hill had two branches almost normal and two branches with distorted, thick or fleshy, glabrous leaflets. Of the second, third, fourth and fifth generations, grown in the field the next four summers, each showed a range from absence to completeness of sporting among the various hills, and even among the various leaves of one hill, and among the leaflets of a single leaf. Fig. 19 shows a completely abnormal leaf and one partly normal. The original plant in 1918 yielded six tubers, which in 1919 produced sixteen plants of which nine were more or less abnormal. Seven of these nine hills were kept. The percentage of their leaf area estimated to be abnormal, ranging from ten to one hundred per cent for the different plants, was not correlated with the abnormality percentages of their progeny hill-lots. In 1920, ten hills were selected as having less than half of the foliage abnormal, and ten with more than half. These two ten-hill parts of the strain were not obviously different from each other in 1921, though as previously stated, there was a complete range of difference between hills. Only a few of the most abnormal hills were kept in 1921, but in 1922 there was again a variation, normal or partly normal foliage appearing. It seems, then, that the thick-leaf type of sport, though probably occurring more frequently than the simple-leaf type, is somewhat less stable.

Partial recovery after two generations of complete abnormality, with normal leaflets or leaves then appearing with abnormal ones as parts of the same structure, precludes these sports from being classed with degeneration diseases. From such diseases there is no true recovery as long as propagation is by tubers,[1] and apparent recovery (climatic suppression of symptoms) is not confined to indiscriminately scattered leaflets, leaves, and plants.

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CONTENTS

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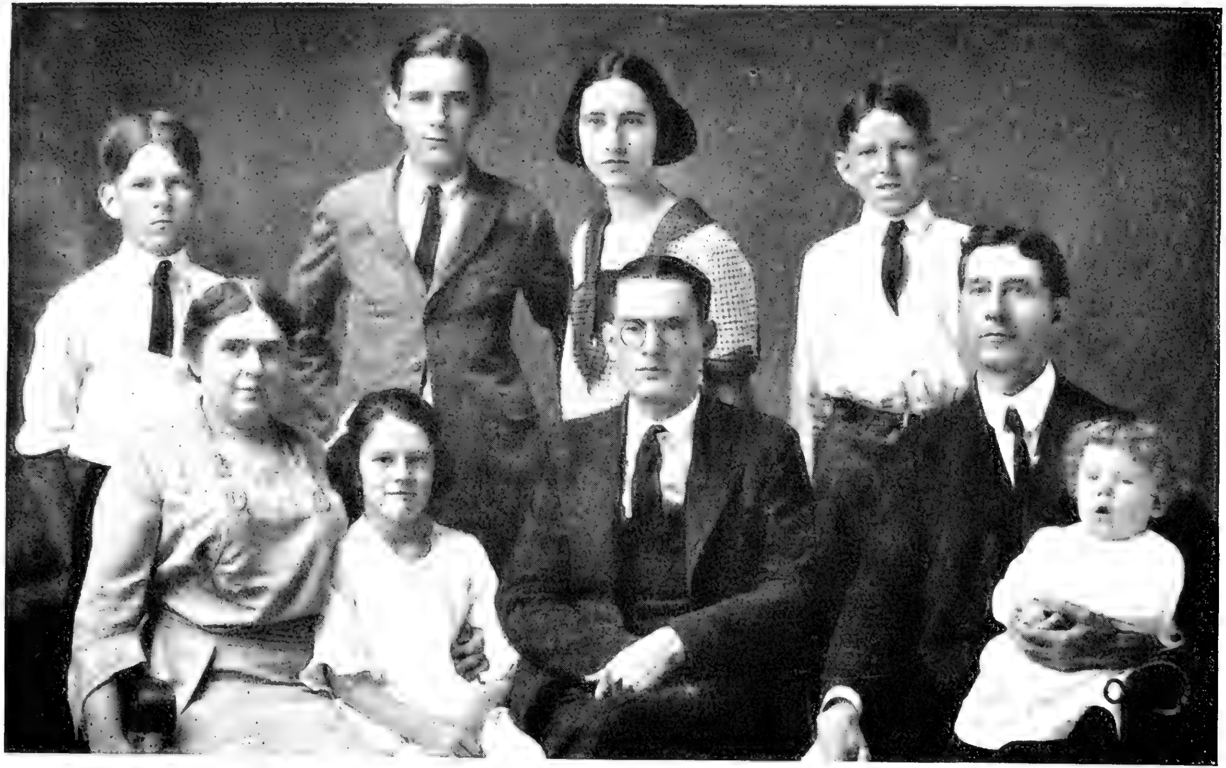

NO RACE SUICIDE IN THIS ALLEGHENY COLLEGE FAMILY

FRONTISPIECE. Not many families of the graduates of Allegheny College were found to be as large as this one. During the thirty-year period studied no marked decrease in the size of the families occurred, but even at the beginning of the period the children of Allegheny graduates were too few to replace their parents. This family could be divided into three "average families" of the group as a whole. When all factors are taken into account, two and a fraction children fall decidedly short of being enough to perpetuate this very desirable element of the population. This finding confirms what other investigators have found to be true of the families of the graduates of the larger colleges, and shows the tendency of this select element of the population to diminish in numbers under existing economic and social conditions. Our institutions of higher learning appear to aid in reducing the proportion of eugenically superior families. No doubt the next suggestion of radical reformers will be to send defectives to college to be sterilized, and keep the good stocks outside to raise families.

THE ALLEGHENY COLLEGE BIRTH RATE

H. R. Hunt

University of Mississippi

THE present study was undertaken to determine whether the modern tendency among educated people to restrict the size of the family has reduced the birth rate among the graduates of Allegheny College. It also adds one more link to the chain of evidence showing that a high state of civilization curbs reproduction among the more intelligent elements of society.

Allegheny College was founded in 1815 at Meadville, Pennsylvania. The present enrollment is about 560 students (men and women). The college has been for years under the patronage of the Methodist Episcopal Church. As a consequence the moral and religious elements in the education of the students have been emphasized. The institution is a good representative of the strong, coeducational, Christian college of the middle west.

The progress, or even maintenance, of civilization depends in part upon the production of a sufficient number of capable and cooperative men and women. There is a difference of opinion, however, as to the effective means of maintaining an adequate supply of them. Some assume that the human mind at birth is a clean slate upon which environmental factors inscribe the symbols of character and capacity. The view which prevails among eugenists, however, is that heredity is fully as potent as environment in framing the course of the individual's physical and mental development. Men are not "created equal." The available evidence supporting this view has been repeatedly presented in the pages of the Journal of Heredity. However, the idea that only environmental agencies shape the human mind, and that heredity has little or nothing to do with moulding it, is so prevalent that a brief and incomplete summary of the evidence may help to clarify the reader's ideas.

Is Intelligence Inherited?

In the first place, variation is of such universal occurrence among animals and plants that one may regard it as a fundamental property of living things. A large number of these variations is known to be inherited.[1]* If variations in human mental capacity were not inherited, the mind of man would present a very conspicuous anomaly in the realm of life.

Secondly, many physical variations in man are known to be inherited. This fact increases the probability of some mental variations being transmitted, for it shows that man is no exception to the laws of variation. Bell[2] and Pearson[3] (cited from Pearl) have demonstrated that the physical vigor which leads to long life is inherited. Pearson (cited from Pearl) has demonstrated the inheritance in man of variations in stature, span, length of forearm, eye color, cephalic index, and hair color. Huntington's chorea, color blindness, night blindness, exosteoses, polydactyly, skin color, defects in dentation, ichthyosis, haemophilia, and numerous other physical variations from the normal are known to be inherited in man.[4] It is highly probable, in the face of such evidence, that the human brain varies like other organs of the human body, and that some of these variations are inherited. Such variations would express themselves as

*For numbered references, see Literature Cited at end of article.

fluctuations in mental capacity of one kind or another.

Our belief in the variations in human intelligence rests not only upon deductions from the general principle of variation, but also upon direct observations on the human mind itself. Yerkes[5] and his associates organized and conducted a prodigious experiment in mental testing in the United States Army during the World War. A sample, consisting of over 162,000 men, was selected for analysis from the nearly 2,000,000 psychological record cards sent in from the various army camps. The analysis revealed great variation in mental ability. Much of the fluctuation *may* have been due to differences in educational opportunities; part of it was probably caused by inborn differences in ability. This is shown by a comparison between 660 officers, none of whom had gone beyond the eighth grade, with 13,943 native white drafted soldiers of high school or college education. Though the best educated officer in the group had received less education than the least educated recruit, the average rating on examination alpha for the officers was slightly *higher* than that for the recruits. Apparently the inferior training of the officers was offset by an average inborn intelligence superior to that of the recruits.

Goddard[6] has demonstrated the inheritance of feeblemindedness. Degrees of feeblemindedness range from idiocy and imbecility through the higher grades (morons) to types which we would characterize as mentally dull. There is no sharp boundary between the feebleminded and the "normal" categories of persons. Therefore, if the lower ranges of the scale of intelligence are often inherited, why not the higher also? There is no little evidence to support such a conclusion. Galton's classic studies revealed that British men of genius were almost without exception descended from families in which great intellectual ability was the rule.

Frederick Adams Woods in his fascinating book, "Mental and Moral Heredity in Royalty,"[7] has shown that both mental and moral qualities are inherited.

The reader who is interested in examining a very good summary of the evidence that mental capacity is inherited, will find it in Popenoe and Johnson's "Applied Eugenics," chapter 4.[8] Briefly, part of the evidence as presented is as follows:

(1) Mental traits (insanity and feeblemindedness) segregate in successive generations much like other traits which are known to be inherited.

(2) Resemblances in twins persist in spite of differences in the environment; unlike qualities in twins persist in spite of sameness in the environment (Galton).

(3) Older twins do not show greater resemblance than younger ones, though the former have been subjected to the same environment longer than the latter (Thorndike).

(4) Thorndike's experimental work also shows that, "Equalizing practice seems to increase differences. The superior man seems to have got his present superiority by his own nature rather than by superior advantages of the past, since, during a period of equal advantages for all, he increases his lead."

(5) Pearson finds that the average coefficient of correlation with respect to several mental traits in brothers and sisters is about .5. The same degree of resemblance exists for physical traits known to be inherited.

The facts amply justify the view that men differ greatly at birth in their inherited mental endowments, and that these differences exert a profound influence upon their lives.

It is therefore important to determine whether mentally superior stocks are holding their own numerically in our increasing population. If unusually good families die out or decrease it is not probable that their loss can be made good by the substitution of in-

nately mediocre stock, even though educated in the most approved fashion.

Fecundity and Intelligence

There are indications that the percentage of unusually capable persons is decreasing in the population of the United States.

Regarding the city of Pittsburgh, Johnson, Popenoe, and Scorer[9] report:

"Taking into account all the wards of the city, it is found that the birth-rate *rises* as one considers the wards which are marked by a large foreign population, illiteracy, poverty, and a high death-rate. On the other hand, the birth-rate *falls* as one passes to the wards that have most native-born residents, most education, most prosperity—and, to some extent, education and prosperity denote efficiency and eugenic value."

Cattell[10] in his study of American scientists finds that their marriage rate is high and the death rate for their children is unusually low.

Yet he concludes, "A scientific man has on the average about seven-tenths of an adult son. If three-fourths of his sons and grandsons marry and their families continue to be of the same size, a thousand scientific men will leave about 350 grandsons who marry to transmit their names and their hereditary traits. The extermination will be still more rapid in female lines."*

Cattell shows (Table IX) that 643 scientific men, employed in universities and other institutions, have an average of but 2.28 children each.

Nearing[11] remarks in the course of a study of the birth rates in different sections of Philadelphia, (foot note, p. 635), "Such figures merely confirm in a broad way the fact of common experience—large income, small family, and *vice versa*."

Similar conditions appear to exist in Europe. Bertillon (cited from Holmes,[12] p. 132), studying the birth rate per thousand women between fifteen and fifty years in Paris, Berlin, Vienna, and London, furnishes data which show that the poorer the district of the city, the higher the birth rate.

A statement from Holmes (p. 134) is worth quoting in this connection:

"Several of Pearson's colleagues found in the laboring population of English towns that there was a fairly high correlation between large families and dirty homes (.41), low rent (.31), poor food (.33), insufficient food (.35), low wages of father (.32), and irregularity of employment. We may explain the low rent and the poor and insufficient food of large families as, in part at least, a consequence of their large size. There seems, however, no good reason to suppose that the possession of a large family would have any effect in lowering the wages of the father. Wages are at least a rough measure of the efficiency of the individual worker, and the fact that the men who are poorly paid have a larger number of children than those who receive better wages indicates that the less efficient types have the highest degree of fecundity."

A glance at recent immigration statistics is suggestive. Table I shows the relation between fecundity, mental capacity, and numbers of individuals in this country, of several classes of the foreign-born. The data on birth rates are taken from Holmes.[12] The army mental tests furnish the ratings of average mental capacity of the various classes presented.[5] Classes A and B include the most intelligent soldiers, classes D, D-, and E the least intelligent.

"In general," says Holmes, "The women of native white parentage had 2.7 children, while those of foreign parentage had 4.4."

Without data on death rates it is of course impossible to determine the rates of net increase in these eleven groups.

* About 75 per cent of the graduates of Harvard and Yale marry; and about 50 per cent of the graduates of women's colleges marry.

These observations strongly support the view that some of the highly fecund stocks (Russians, Poles, Italians, etc.), which form a large part of our more than thirteen millions of foreign-born whites, are of comparatively low intelligence. This does not mean that the average intelligence in the particular countries from which these immigrants came is inferior to ours; it may only signify that the poorer material migrates to us.

Such rather unpromising strains are helping to fill the gaps left by the dwindling old American families that have made the country what it is. We should welcome those immigrants who are morally and mentally our equals or superiors; they may bring us strength and stability. But we must be cautious about admitting inferior strains. The whole problem of immigration should be very carefully studied at this time, not by politicians, but by scientifically-minded persons who are competent to discover the facts, and to recommend which types should be admitted and which excluded.

The Families of College Graduates

Let us turn now to a consideration of the reproductive rate among college graduates. Keeping in mind the fact that mental ability may be inherited, the marriage and birth rates among college graduates are eugenically important, because these persons are undoubtedly above the average mentally. Anyone who has run the gauntlet of the public school and college courses realizes that the vast majority of his schoolmates (not far from 99 per cent according to the report on the army mental tests) drop out of the race before graduation from college. Many leave school, no doubt, for economic or temperamental reasons, but unquestionably a large proportion depart because they are mentally unable to maintain the pace. The army mental tests confirm this view (Part III, Chapter X). The examiners conclude:

"Distinctly more than average intelligence would seem to be a prerequisite to a college education, and almost as strictly a prerequisite to graduation from or even entering high school."

It is disquieting to note, in the light of the facts stated in the last paragraph, that the birth rate in this selected group, college graduates, is comparatively low.

Johnson and Stutzmann[13] have studied the classes of Wellesley College which graduated from 1879-1888. Only fifty-five per cent of the women had married. The number of children per graduate was .86; per wife, 1.56 Such absurdly small families obviously fall far short of replacing the excellent stock from which these girls doubtless came.

Popenoe and Johnson[9] furnish the data for the following citations. The number of children per graduate from Mount Holyoke College has declined from 2.37, for classes graduating from 1842 to 1849, to .95 per graduate for those graduating during the years from 1890 to 1892. Bryn Mawr graduates in the classes from 1888 to 1900 had borne only .37 of a child per graduate by 1913. Sprague finds that of the graduates of Vassar College in the classes from 1867 to 1892, 53 per cent married. There was an average of 1.91 children per married graduate, and but 1.00 child per graduate.

Phillips[14] has studied the birth and marriage rates among the graduates of Harvard and Yale in the classes from about 1850 to 1890. At Harvard the average number of children per graduate has decreased from 1.98 (1861-1870) to 1.55 (1881-1890). At Yale the corresponding data are 2.53 children (1850-1859), and 1.53 (1881-1890).

Banker[15] has demonstrated a decrease of the birth rate in the families of men and women liberal arts graduates of Syracuse University. The average number of surviving children of the women graduates, per graduate, of the classes of 1852 to 1861 was 1.73. This

figure decreased to 1.06 children for the classes graduating in 1872-1881, and to .52 of a child for the period 1892-1901. Likewise the average number of the men graduates' children surviving, per graduate, declined from 2.12 for the classes of 1852-1861, to one child each in the period 1892-1901.

The writer[16] found that better matrimonial ideals prevail among the students of the University of Mississippi than seem to have dominated recently the students in the institutions just mentioned.

The foregoing discussion prepares us for a more intelligent appreciation of the facts bearing on the marriage and birth rates among the Allegheny College graduates.

Families of Allegheny Graduates

The collection of data presented many practical difficulties. In the first place the college has not preserved adequate records of marriages, and none of births. It was therefore necessary to mail questionnaires to surviving men and women graduates, depending entirely upon their interest and good will for satisfactory replies. The Alumni Register of 1921 furnished the names and addresses and indicated those graduates who had died. A valuable supplementary source of information was a booklet published by the Class of 1890.

A study of the birth rate in such a group would be of little value if the families were not complete, or for the most part nearly so. Hence the class graduating in 1899 was the latest one studied. It was assumed that the ages of the wives in families one of whose consorts graduated not later than this date, would as a rule approach or exceed 45 years, the usual limit of the child bearing period. The collected data accorded with this belief in a general way.

The proportion of deceased members in the classes before 1870 was so large that it was deemed unwise to attempt to study classes of an earlier date.

A questionnaire was sent in January and February 1922, to each of the living graduates of the classes of 1870 to 1899. In April a second copy of the questionnaire was mailed to each person who failed to return the first, with the urgent request that the data be forwarded. This somewhat enlarged the returns, but not enough to warrant a third attempt. Fifty-seven per cent. of all questionnaires were returned. Criticisms based on the incompleteness of our data, however justifiable statistically, should be tempered by the fact that much desirable information was apparently not obtainable by any readily available means.

The essential features of the questionnaire sent to the men are reproduced below. After a brief preliminary explanation, the following questions were asked:

(1) Name.
(2) Are you single, married, divorced, or a widower?
(3) What was your age at graduation from Allegheny?
(4) If married, what was your age at marriage?
(5) If married, how many children have you? Number living .... Number deceased ......
(6) If married, what is your wife's present age?
(7) Supplimentary information or remarks.

The following persons who graduated from Allegheny College in your class are now dead. Please answer the above questions for each one of these deceased classmates, as far as you can do so accurately. Write the information on a separate sheet of paper, or on the back of this sheet.

The women's questionnaire so closely resembled the men's that it need not be reproduced here.

Table 2 shows the total number of alumni, the number living, and the proportion of questionnaires filled out and returned.

Before proceeding to a critical analysis of the marriage and birth rates a glance at some of the raw data may be of interest. These are presented in Table 3.

The discrepancy between the total number of individuals listed in Table

3 (number single plus number married) and the number of questionnaires returned, as shown in Table 2, is due to the fact that the information concerning only the marriage of some deceased graduates was furnished on many questionnaires, and this information has been incorporated in the columns "Number single" and "Number married" of Table 3. Other apparent discrepancies in the number of persons listed in Table 3 are due to the fact that the ages at graduation or marriage of many persons were not given. Information concerning many individuals was fragmentary.

It is evident that during the three decades the per cent marrying, the age at graduation, and the age at marriage remained fairly constant for both the men and the women. The low average age at marriage for the women in the classes of 1873-1879, as well as the great fluctuations in the percentages of childless married women graduates, may be due to the small number of families concerned.

Before indicating the conclusions which logically follow from the analysis of the data, it is necessary to consider some of the data's limitations and peculiarities.

(1) The number of individuals dealt with is small. Consequently, the conclusions arrived at are of general significance only when considered in connection with researches among graduates of other colleges, and among other sections of society.

(2) Sometimes it was not clear whether the number of children indicated included deceased children. The data on children in such questionnaires were not used in the following computations.

(3) The age of the wife in many cases was less than 45 years. Women under that age may have more children. Only sixteen wives were less than 40. Thirty-one ranged in age from 40 to 44. As will be evident later, two series of computations were made: one including all families whose total number of children to date was ascertained, and another using the same data, though excluding all families which may still produce more children.

(4) The 554 living graduates form a group which has survived thus far the ravages of disease. They are doubtless much healthier on the average than their 180 colleagues (24.5 per cent of the individuals of the period studied) who are deceased. Bell[2] has shown that long-lived persons have more children on the average than short-lived ones. Therefore, the surviving seventy-five per cent of the graduates were doubtless more fecund on the average than the whole group of graduates combined.

This view is confirmed in a limited way by the fact that the mean family size was 1.07 children in the families of fourteen deceased male alumni. The total number of children in each family was known. Compare this figure with the families in Tables 5 and 6.

About ninety-four per cent of the married graduates (men and women), whose children are used in our compilations, are living. Hence the fecundity of the married individuals who returned the questionnaires has doubtless, like that of the living alumni in general, been higher than for the whole group of graduates, living and dead. This fact should be kept in mind.

The deaths have naturally been relatively more numerous among the earlier graduates (38 per cent for the period 1870-1884) than among the later (17 per cent for the period 1885-1899). The fact that the number of children per capita is larger in the earlier period than in the later (see Tables 5 and 6) is doubtless due in part to the more highly selected condition of the earlier group.

There is no reason, however, for suspecting that those who returned the questionnaires are any more or any less vigorous physically than those, still living, who did not return them.

(5) It is probable that those who filled out the blanks are more interested, in general, in children than those who did not. A person whose interest in children has never been very great might frequently disregard such a questionnaire as unimportant. Such people are not as likely to have offspring as those who are interested in children. Therefore, there is reason for believing that the number of children per capita reported is larger than it would have been had the whole group of living graduates returned the questionnaires.

(6) A determination of the number of children per graduate would have to be based on a group selected in such a way as to have nearly the same percentages of married and unmarried persons as in the alumni body as a whole, if the determination were to present accurately the facts for the latter. The Alumni Register for 1921 shows that 56.9 per cent of all the women graduates in the period 1870-1899 were married. The percentage of married women (excluding those whose complete family size to date was not given) in the data derived from the questionnaires was 56.2 per cent. When *all* the women reported in the questionnaires (52 married and 32 single) are considered, the percentage of married is 61.9 per cent. This shows that the ratio of married to unmarried women in our sample is not far from the corresponding ratio for the whole group of graduates. It establishes a strong presumption that a similar relation would be found among the men if we had the means (which we do not) of determining the ratio between all the married and unmarried men.

The numerical representativeness of our sample is also indicated by the fact that the percentages of men and women who filled out questionnaires are almost the same as in the whole alumni body of the period studied. The percentage of men is 89.1 in the group returning the blanks, and 87.1 in the Alumni Register, for the period 1870-1884. The corresponding percentages of men for 1885-1899 are 77.7 and 76.6.

In conclusion, the sample studied has doubtless been somewhat more prolific on the average than all the graduates from 1870-1899, and then the living group as a whole. It is representative as far as concerns the ratios between the sexes, and married and unmarried women (probably men too).

We are now ready for an analysis of the facts in the light of the foregoing criticisms. The general conclusions may be summed up in the answers to three questions.

a. Has the marriage rate significantly decreased?

b. Has the birth rate diminished significantly?

c. Has the group produced enough children to replace itself?

a. The marriage rate has not significantly decreased, either for the men or the women. See Table 3. Neither has there been any radical change in the age at marriage. The data for formulating the "Per cent married" column for the men in Table 3, were derived from the questionnaires. The Alumni Register for 1921 does not indicate which men are married. The Register does, however, differentiate married from single women. The data for the women in this column were derived, therefore, from the Register. About ninety per cent of the men and fifty-six per cent of the women are married.

Doubtless the difference in the marriage rates between men and women is partly due to a desire on the part of many of the women to enter upon a career, rather than to accept opportunities for marriage.

In only one case (between men of the second and third decades) does the difference between the percentages of married men or women in successive decades exceed the probable error of the difference. In that instance the ratio of the difference to its probable error is 1.07. It is evident that these

data do not show any significant decrease in the marriage rate.

b. There has not been a statistically significant decline in the birth rate among the male graduates concerning whom adequate information was furnished by the questionnaires. The total number of married women, the sizes of whose families were definitely determined, was so small that comparisons of the birth rates in their families have little value.*

Table 4 shows the average number of children per male graduate and per married male graduate by five-year periods. The total number of children to date was ascertained for each of the families represented. Doubtless some of these families, particularly of graduates in the later periods, are not complete yet, for the wives' ages are less than 45 years.

Table 4 shows fluctuations from period to period, but no clear evidence of a general or progressive decrease in family sizes. This conclusion is borne out by the more refined analysis that follows.

The data for the men are massed in Table 5 in two fifteen-year periods instead of six five-year periods. Here again only the families are included in which the total number of children to date (deceased as well as living) was furnished.

(To be concluded in June number)

* The full sizes of 27 women's families were ascertained. The 7 women graduating from 1874-1884 had an average of 2.4 children. The 20 graduating from 1885-1899 had an average family of 1.9 children. This computation does not include 14 women who married male graduates, and whose children were therefore included in the determination of birth rates in the men's families.

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[17] HENDERSON, R. *Mortality Laws and Statistics,* first edition, John Wiley and Sons, New York. 1915. The table used is on page 107.

TABLE 1. *Mental ratings and average number of children in ten foreign-born groups in the United States.*

Country of Birth	Average number of children per wife	Mental Ratings: Per cent D, D-, and E	Mental Ratings: Per cent A and B	Number in United States, 1920. Census, 1920.
Poland	6.2	69.9	.5	1,139,978
Russia	5.4	60.4	2.7	1,400,489
Italy	4.9	63.4	.8	1,610,109
Norway	4.7	25.6	4.1	363,862
Austria	4.6	37.5	3.4	575,625
Ireland	4.4	39.4	4.1	1,037,233
Germany	4.3	15.0	8.3	1,686,102
Sweden	4.2	19.4	4.3	625,580
Scotland	3.6	13.6	13.0	254,567
England	3.4	8.7	19.7	812,828
Whole white draft		24.1	12.1	

TABLE 2. *Data regarding number of Allegheny graduates, and number and per cent of questionnaires returned.*

Period of graduation	Total number of graduates: Men	Women	Number of living graduates: Men	Women	Per Cent living	Questionnaires filled out and returned: Men	Women	Per cent combined
1870-1884	229	34	135	28	62.0	82	10	56.4
1885-1899	361	110	296	95	83.0	174	50	57.3
1870-1899	590	144	431	123	75.5	256	60	57.0

TABLE 3. *Married and single graduates of Allegheny College.*

Period of graduation	Number single	Number married	Per cent married	Average age at graduation	Average age at marriage	Per cent* childless marriages
MEN						
1870-1879	5	57	91.9 ± 2.4	23.1 36 persons	28.1 35 persons	15.0
1880-1889	12	123	91.1 ± 1.65	24.2 98 persons	31.5 88 persons	13.5
1890-1899	19	148	88.6 ± 1.66	23.6 136 persons	29.5 130 persons	19.0
WOMEN						
1873-1879	5[A]	9[A]	64.3 ± 8.6	20.8 5 persons	23.7 3 persons	0
1880-1889	25	30	54.5 ± 4.5	21.7 23 persons	28.9 11 persons	44.4
1890-1899	33	42	56.0 ± 3.8	22.2 38 persons	27.6 24 persons	21.4

* The computation of the percentage is based only on those families in which the total number of children to date is known. The families of women graduates who married Allegheny men graduates are not included in the "Per cent childless marriages" of Women.

[A] Data taken from the Alumni Register for these two columns.

TABLE 4. *Children per married graduate and per graduate.*

Half Decade	1870-1874	1875-1879	1880-1884	1885-1889	1890-1894	1895-1899
Children per married graduate, where the total number of children in the family is known.	2.4	2.8	3.3	2.8	2.3	3.0
Children per graduate. (This computation is based only on single graduates, and graduates in whose families the total number of children is known.)	2.1	2.4	2.9	2.4	2.1	2.5

TABLE 5. *Children per married male graduate, and per male graduate (married and single.)*

Period	1870-1884	1885-1899
Children per married male graduate where the total number of children in the family is known................	80 families 2.93 ± .17	174 families 2.64 ± .10
Children per male graduate. Includes all single alumni reported, and all married alumni in whose families the total number of children to date is known...........	90 individuals 2.60 ± .16	200 individuals 2.30 ± .10

TABLE 6. *Revised table of number of children per male graduate.**

Period	1870-1884	1885-1899
Average number of children per married male graduate..	64 families 2.95 ± .18	112 families 2.71 ± .13
Average number of children per male graduate..........	70 individuals 2.70 ± .18	126 individuals 2.41 ± .12

* A final checking of the original data revealed a few comparatively unimportant omissions in the preliminary report which appeared in the program of the American Society of Zoologists (1922). The inclusion of several families of dead alumni lowered the average sizes of completed families to those shown in Table 6. These families, together with the additional inclusion of a few second wives of men graduates, are responsible for the changes from the abstract in the sizes of the parental groups and the number of children produced by these groups. (See Tables 8 and 10.)

A Textbook of Gardening

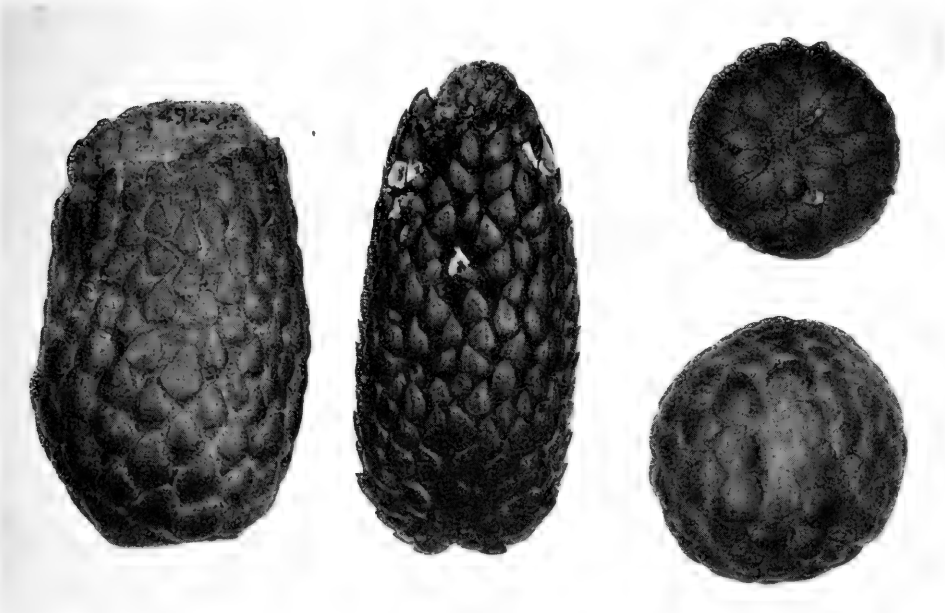
GARDENING, by A. B. STOUT, Director of Laboratories, New York Botanical Garden. World Book Co., New York, 1922.

An elementary textbook on vegetable gardening for use in the grades. This book includes a chapter covering plant breeding and garden seeds. In simple language, is given a discussion of the development of new varieties of horticultural plants using as illustrations corn, tomatoes and the pumpkin. The material included has been carefully selected and effectively presented. It should be welcomed by teachers who wish to give children an appreciation of this side of plant life.—*G. M. D.*

AN EAR OF PREHISTORIC MAIZE THAT RESEMBLES THE FOSSIL FORM, ZEA ANTIQUA

G. N. COLLINS

Bureau of Plant Industry, U. S. Department of Agriculture



The Fossil Ear The Arica Ear

PREHISTORIC EARS OF MAIZE

FIGURE 1. The Arica ear was taken from a prehistoric grave near Arica, Chile. The fossil ear comes from Peru, although the exact region in which it was found is not known. On the right are the butts of the two ears. The ear-stalks are so small that the ears must either have drooped or been supported by the surrounding leaf sheath. Nearly all of the characters exhibited by these ears can be duplicated in existing varieties of maize—a remarkable demonstration of how little maize has been changed since prehistoric times.

WHEN *Zea antiqua* was described as a new species by Dr. Knowlton[1] it was not found possible to point to a modern variety of maize with ears closely resembling the fossil ear on which the new species was based. Although the fossil ear presented no new characters, no modern variety was known possessing the particular combination of characters exhibited by the fossil specimen. But in view of the great freedom of recombination in the maize plant with respect to all its characters, including those of the ear, no special importance was attached to this failure to find a modern ear duplicating the fossil ear in every particular.[2]

[1] KNOWLTON, F. H. Description of a Supposed New Fossil Species of Maize from Peru. *Jourl. Wash, Acad. Sci.,* Vol. ix, No. 5, pp. 134-136, March 4, 1919.

[2] COLLINS, G. N. A. Fossil Ear of Maize. *Journal of Heredity.* Vol. x, No. 4, pp. 171-172, April, 1919.

The close relationship of *Zea antiqua* with modern or recent types of maize is now demonstrated by the discovery of a beautifully preserved ear in a grave near Arica, Chile. The Arica specimen is so like the fossil ear that if the two specimens were contemporaneous they might be referred properly to the same variety. The Arica specimen was unearthed by Colonel John W. Gulick and came to my attention through the kindness of Miss Caroline Rumbold. Colonel Gulick kindly has prepared the following statement of the conditions under which it was found:

> The ear of "maize" was found by me in an Indian grave or tomb in 1913 at Arica, Chile, formerly a part of Peru. My work in Chile was in connection with her Coast Defenses and in mounting a number of 6-inch guns on the "Morro" of Arica (a cliff rising about 250 meters out of the sea), it was necessary to take the guns up by means of a zig-zag track of light rails laid on the land side of the cliff. During these operations we ran into a large group of graves or tombs which were in an excellent state of preservation due to the climatic conditions and the presence of crude nitrate in the soil. As you are doubtless aware, this is an extremely arid area. The Chilean soldiers, knowing that I was interested in the history of the ancient people, assisted me in securing quite a collection of pottery, implements, toys, fabrics, etc., from these tombs. Each body was provided with a bag which contained a collection of small pots or vessels for food or drink. In some, quantities of cocoa leaves or "mate" would be found. The ear of "maize" was found in one of these bags.

The country about Arica has practically no rainfall, and maize is not now grown in that region. Remains of irrigation works indicate that streams arising in the mountains formerly were diverted and used for the growing of crops.

The Arica ear (see Figs. 1 and 2), is somewhat smaller than the fossil, which is incomplete, but presents practically the same characteristics. It has small, pointed grains, irregularly disposed in approximately 20 rows. The grains are borne over the entire base of the ear which is somewhat enlarged as in the fossil and the ear stalk must have been extremely slender. Existing varieties with such small grains usually have an endosperm that is almost completely corneous and are classed as pop corns. Unless age has changed the nature of the endosperm, however, the prehistoric ear is not a pop corn, for the seeds now are filled with soft starch, the starch grains being spherical. We never before have seen a variety of soft corn with seeds so small as those of the Arica and the fossil ears.

An examination of the endosperm of the maize from Arica was made by Dr. E. H. Toole, who found it to be true starch, staining blue or purple with iodine.

Since the fossil ear undoubtedly represents the earliest type of maize of which we have knowledge, it may be of interest to examine the type as interpreted by the Arica specimen and call attention to such characters as may be considered primitive.

Size: The Arica specimen, which is somewhat smaller than the fossil ear, also is smaller than the ears of any commercial variety except some of the pop corns. Commercial varieties with small ears have also small plants, a general reduction in size having accompanied selection for earliness. Many of these small varieties are very efficient and produce a large amount of grain in proportion to their total weight.

Small ears, therefore, may not be considered primitive unless they are borne on relatively large plants. There is at least one variety from Peru with ears as small as the Arica specimen and with plants over two meters in height.[3]

Shape: The tapering form of the ear is perhaps a primitive character, since in this rather extreme degree it

[3] An ear of this variety is shown natural size as Nos. 5 and 6 of Fig. 7. *Journal of Heredity*, Vol. x, No. 4, p. 171, April, 1919.

THE ARICA EAR AS FOUND IN A PREHISTORIC GRAVE

FIGURE 2. The grave was excavated in the face of a cliff on the coast of Chile, in a region where no maize is grown today because of extreme scarcity of water. Remains of irrigation works indicate that the ancient inhabitants brought water for their crops from the distant mountains. This region gives evidence of having been the home of a numerous prehistoric people, but just how long ago they lived is not known. When the Spaniards arrived the coast of Chile was as much a desert as it is today.

is found only in unimproved varieties grown by native tribes. Many of these, however, have ears fully as tapering as in the prehistoric form. On the other hand, the rounded butt with grains extending over the base of the ear usually is considered a mark of good breeding. The strikingly small ear stalk of both the fossil and Arica specimens is a character much desired in commercial varieties on account of the ease in shucking, and no existing variety is known with ear stalks so slender as those of the fossil and the Arica specimens.

Number of Rows: The large number of rows of spikelets on the ear and the central spike of the tassel is one of the most striking characters that separate maize from all related grasses. It would be expected, therefore, that a truly primitive form would have a small number of rows. In modern varieties the number ranges from eight to something over thirty but it is not certain that the eight-rowed types are more primitive or less highly specialized. Eight-rowed varieties are most common near the northern limit of the geographic range of maize and where they reappear in South America it is in connection with the highly specialized, large-seeded Cuzco and related varieties grown at relatively high altitudes.

The irregular arrangement of the grains in both specimens makes it impossible to determine accurately the number of rows. There are, however, at least twenty in the Arica specimen and probably twenty-two in the fossil ear. These numbers are well above the average of modern varieties.

Arrangement of Grains: The lack of regularity in the arrangement of the grains may be considered a primitive character if the ear is assumed to have originated by the shortening and twisting of a four-rowed spike. But if the ear originated through the fasciation of lateral four-rowed branches the irregularity must represent a specialization of the original form. Irregularly disposed grains are a common variation in many varieties but are characteristic of none except the sweet variety, "Country Gentleman," where the irregularity is due to the development of both of the flowers of the spikelet. In the Arica specimen only one flower is developed in the spikelet.

Size of Grains: The grains are small but not smaller than in many varieties of pop corn. Since the endosperm of the Arica specimen is composed of soft starch the specimen may not be called a pop corn and since these specimens represent the smallest grains with soft endosperm the small size perhaps may be looked upon as primitive.

Shape of Grains: Grains with such a pronounced point or beak are rather unusual except in the pop corns. The resemblance to pop corn varieties in the shape of the grains probably is accidental, a closer relationship being with the large-seeded, soft varieties with beaked grains common in South America. Although very sharp, the beak is less pronounced than in some of the Bolivian varieties and these prehistoric forms may represent the beginning of this specialization.

There are no characters of these early ears that suggest the pistillate spike of teosinte, the nearest wild relative of maize, more closely than existing varieties of maize. The small ear stalk, the irregular arrangement of the grains and the soft endosperm associated with small grains are the only characteristics not included in the range of modern varieties.

While the Arica specimen may not be said to throw much light on the development of maize it serves to link the fossil specimen more closely with existing forms and gives added proof of the great permanence of the germ plasm of maize. It further emphasizes the fact that all the important steps in the domestication of maize took place at least as early as the period represented by the fossil ear.

Medical Eugenics

Die Pathologisch - Anatomischen Grundlagen der Frauen-Krankheiten, 24 Fortbildungsvortraege aus dem Gesamtgebiet der Gynaekologie, by Dr. Wilhelm Lahm, Director of the Laboratories of the Municipal Woman's Clinic of Dresden. Pp. 301; 71 illustrations. Price, $1.40. Dresden und Leipzig, Verlag von Theodore Steinkopff, 1923.

The increasing prevalence of childlessness among American married women has often been remarked. Frederick S. Crum found that the percentage, in the old native-born stock, increased from 1.8 in the last half of the 18th century, to 8.10 in the decade 1879; while J. A. Hill, analyzing the figures of the 1910 census, showed that one in eight native-born wives is childless, as compared with one in five negresses and one in nineteen of the foreign-born. Much of this childlessness is voluntary, but an important part of it is not. Every reader will know, in his own circle of acquaintances, a number of married couples who desire children, and who, from a eugenic point of view, ought to be parents, but are not. The cause in many cases is wholly a mystery, and efforts to clear up this mystery form a very definite contribution to practical eugenics, just as does all progress of obstetrical science toward more painless childbirth. Neither of these lines of research has received as much attention as, from a eugenic point of view, it deserves, but in recent years a number of competent men have published books throwing some light on the causes of childlessness; the work under discussion is an admirably organized and clearly written one. While the study of sterility in the male is relatively simple and easy, gonococcus infection being the usual cause, investigation of barrenness in the female is, for obvious reasons, exceedingly complicated and difficult. Every step forward in this investigation should be welcomed by eugenists. —P. P.

COLORS OF SHORT-HORN CATTLE

Analysis of Genetic Factors Underlying Color Inheritance In Short-Horn-Cattle

Russell W. Duck

Animal Husbandry Department, Syracuse University

TO WRITE a definite formula that would fit all cases of Short-Horn color inheritance is very difficult. The problem is complicated by the number of different recognized colors: red, red and white, roan, and white. It is also difficult to secure accurate data from the herd books, because of the occasional blending of these colors into one another, thus giving conflicting ideas of the color in question. This is influenced to some extent by the popularity of the color. Plumb[1] gives the relative proportion of the different colors of Short-Horns at two different periods, as shown in Table I. The author computed the colors of part of the animals registered in the herd book in 1921. The records of a total of 10,000 animals were studied and the results obtained are shown in the last column of the same table.

These tables show the decreasing popularity of red-and-white. The gradual elimination of herd bulls of this color is having a considerable influence on the total number of red-and-whites registered. The increasing popularity of roans, and the frequent selection of roan or white herd bulls has materially increased the number of roans registered in 1921 as compared with those registered in 1859 and 1914.

In attempting to trace color inheritance from the herd books one is immediately confronted by the fact that sources of error are probably very frequent. Exact color classification is extremely difficult; occasionally animals could be classified either as roan or as red-and-white (see Fig. 3.)

Secretary P. K. Groves of the American Short-Horn Breeders' Association states that the rule of the Association is to call all cattle roans if there is roan coloring on any part of the body.

According to Darwin[2], the wild white cattle of Europe did not breed true, and occasionally produced colored calves, although these individuals were never retained in the breeding herd. In this respect the inheritance of white is different from that in the Short-Horn. A true white Short-Horn mated to a true white Short-Horn will produce only whites. It is true that Wentworth[3] presents cases of four reds and eight roans produced from a cross of white on white out of 153 matings. However, this is entirely within the probable limits of error. In tracing 186 matings of white on white, visiting and corresponding with doubtful cases, no case of true red, roan or red-and-white was established.

It was also established that red Short-Horn cattle breed true. In tracing 2567 matings of this character no case of pure white offspring was established from true red on true red. In cases where colors other than red are recorded in offspring as a result of crossing red on red, it will invariably be found that one or both of the parents were marked with white or else that the offspring is incorrectly registered.

The so-called "colors" roan and red-and white of the Short-Horn are,

[1] Plumb, "Types and Breeds of Farm Animals". (Revised Edition).
[2] Darwin, "The Variation of Animals and Plants Under Domestication."
[3] Wentworth, *American Breeders' Magazine.* Vol. IV, No. 4.

REGISTERED AS A ROAN

FIGURE 3. According to the rules of the Short-Horn Breeders' Association, an animal which exhibits roaning on any part of the body may be registered as a roan. Since this is a more popular color than red and white, animals which can be entered as roans are generally so recorded. When roaning occurs on only a small part of the body, as in this case, the animal is assumed to be heterozygous for the extension factor which differentiates the roan pattern from the red and white. This animal is not of the same genetic constitution as the pure roan shown in Figure 4. The pedigree of this animal is given below.

PEDIGREE OF ROSEWOOD RADIUM 512686—ROAN

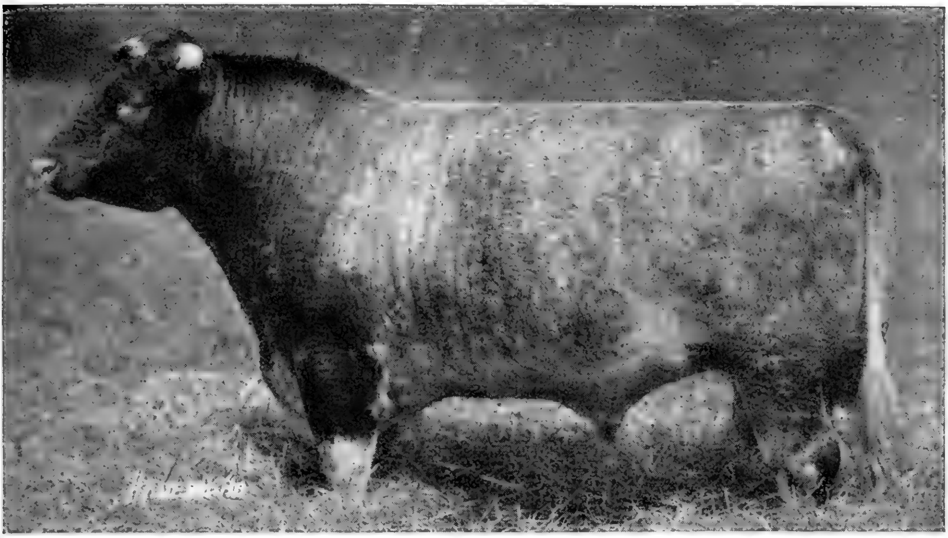
Sire	Radium 385197 White	Double Dale 337156 Roan Lady Fragrant Roan
Dam	Crestmead Rosewood 129176 Red	Scottish Goods 292932 Roan Rosewood 87th Roan

genetically speaking, not separate colors at all, but are obviously a rearrangement of the two colors red with white just discussed. The question of an individual becoming a roan or red-and-white must then depend on the introduction of an extension factor, which we may designate by (E).

Taking the red color as the basis of all combinations it can be represented as a definite color factor (R). The total absence of (R) gives a white individual. White, then, in Short-Horns, is not genetically speaking, a color, but is caused by the total absence of (R) and can be genetically represented as (r).

The Iowa Station[4] gives results from crossing a white Short-Horn bull on pure-bred Galloway cows, with the following results: Twenty-seven blue-gray, and one red-roan. The same bull on grade Galloway cows produced twenty-six blue-gray, one black (attributed to

[4] Jones and Eward, *Iowa Research Bulletin*, No. 30.



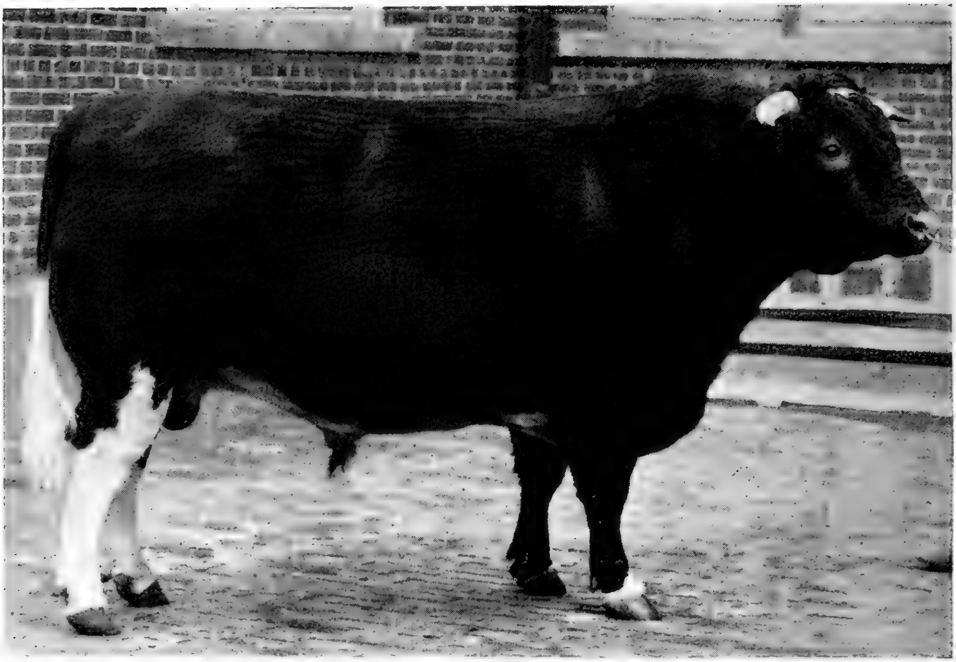
NAEMOOR BRIDEGROOM—A TRUE ROAN

FIGURE 4. Animals "pure," for the extension factor, i. e., those which inherit the extension factor from both parents show the roan pattern over a large part of the body. The largest percentage of roans is produced by crossing red animals and white ones.

Pedigree of Naemoor Bridegroom

BRED BY

Sire	Edgecote Masterpiece 725931. White	Bletchley King 409039. Roan	Silver Mint 323667. Roan	Silver Plate 145554 White-
				Mistletoe 16th V45-934 Red-
			Lancaster 42nd V53-926E. Red, Little White	Bright Stone 409047. Roan-
				Lancaster 41st V53926E. Red-
		Lady Mabel V57-6906. Roan	Pride of Avon 311139 Roan.	Primrose Pride 222709 Roan-
				Rose Blossom V45-4892. Red-
			Mabel 6th V57-941E. Red	Bacchus of Dalmeny 306266. Red-
				Mabel 3rd V38-518E. Roan-
Dam	Miss Helen 891231 Red.	Cupbearer 679630 Red	Collynie Cupbearer 610496 Red.	Jubilant 609047 Red-
				Collynie Princess 4th 557676 Roan-
			Boquhan Claret V54-938E. Roan	Proud Monarch 317044. Red-
				Nora 2nd V54-938E. Roan-
		Stella 2nd 725937 Red.	Earl of Elgin 680234 Roan	Prince of Sanquhar 149558 White-
				Eliza 16th 679390 Red
			Estella 6th 725934 Red	Dorset Prince 680488. Red-
				Estella 725933 Roan



REGISTERED AS RED

FIGURE 5. The presence of a little white on the belly and legs indicates that this bull is genetically red-and-white, but, since the former color predominates, he is registered as red. His pedigree is given below.

PEDIGREE OF DIAMOND GOODS 333014—RED

Sire	Good Choice 227852 Roan	Choice Good 186802 Roan Silence 2nd V45-1263 Red
Dam	Sweetheart 13925 Red	Victor Allan 212209 Red Modesty Red

incorrect recording), six red-roan and two red calves. No black-and-white individuals appeared. As roans do not appear from crossing pure black on pure black, this mating indicates the roan extension factor (E) was carried by the white bull, and that he was also heterozyous for this factor. On the basis of this cross an assumption is possible that the roan extension factor (E) is associated with white in Short-Horns.

J. Wilson[5] assumes that red crossed on white will always produce a roan. This apparently does not hold true in Short-Horns. Whitehall Sultan, a famous white Short-Horn bull, sired many calves out of red cows which are recorded as reds. These so-called reds, though, are carriers of a little white

[5] Wilson, "Mendelian Characters Among Short-Horn Cattle." *Sci. Proc. Roy. Dub. Soc.*, 11.

GENETICALLY PURE RED

FIGURE 6. Pure reds bred to pure reds should always produce offspring of the same color. The contradictory results sometimes obtained from using the data contained in the herd books of the cattle breeding associations are caused by the classification as red of such animals as that shown in Figure 5. Genetically the two animals are not the same, and this fact would be shown by differences in the color of their offspring.

PEDIGREE OF DUKE OF GLENSIDE 813884—RED

Sire	General Clay 255920 Red and White	Duke Buttercup 160769 Roan Mamie Clay 2nd V48-342 Red and White
Dam	Lady Favorite (Imp.) 634158 Red	Coral Favorite 634157 Roan Lady Grace 593355 Roan

and genetically are really red-and-whites. Tracing 1743 matings of this character, almost fifteen per cent of them were registered as red-and-white (See Table III). The logical genetic explanation for the appearance of these individuals is a heterozygous condition of the white parent for the roan extension factor (E). The absence of black-and-white individuals appearing in the Iowa work is due to the fact that the black of the Galloway acts differently than the red of the Short-Horn toward assuring a pied pattern in the phenotype; this is probably due to the presence of some inhibiting factor associated with Galloway black.

That the red of the Short-Horn can also carry the roan extension factor is

A TRUE RED-AND-WHITE

FIGURE 7. The red-and-white pattern is due to a cross between the two colors in the absence of the extension factor, the factor which produces roaning. Of late years this pattern has lost favor among cattle raisers.

PEDIGREE OF AUGUSTA STAMP 920676—RED AND WHITE

Sire	Regal Stamp 396730 White	Sultan Stamp 334974 White	Whitehall Sultan 163573 White	Bapton Sultan 163570 Roan Bapton Pearl V48-368 Roan
			Rachel's Daughter (Imp.) V62-747 Roan	Daybreak 182751 Red Dolly V47-415E Roan
		Autumn Rose V68-709 Roan	Good Morning 182755 (dark) Roan	Joy of Morning 153003 Roan Vain Belle 2nd (Imp.) V46-168 Red
			Queen of the Herd V61-901 Red	Sovereign 157380 Red Cherry Grove Queen V49-857 Red
Dam	Augusta 110th 121392 Roan	Lord Lancaster 270685 Red	Lord Mistletoe 228949 Red, little White	Lovat Champion 157617 Red Mistletoe 3rd V45-434E Roan
			Lancaster Pet (Imp.) V46-140 Red	Scottish Emblem 144668 Red and White Lancaster Fame V45-402E Roan
		Norwood Augusta 4th 38087 Roan	Annabella's Knight 224286 Red	Crescent Knight 180433 Roan Annabella (Imp.) V47-102 Red
			Norwood Augusta 2nd 38085 Roan	Crescent Knight 180433 Roan Augusta 105th (Imp.) V47-102 Red and White

NEWTON CHAMPION—A WHITE SHORTHORN

FIGURE 8. Red in Short-Horns is the only basic color, and white appears to be due to total absence of red. Red-and-white and roan individuals are the result of the red color factor being in heterozygous or dilute condition.

PEDIGREE OF NEWTON CHAMPION 650059—WHITE

Sire	Grand Champion 616773 Roan	Champion of Scotland 387167 Roan	Newton Crystal 340775 White	Opal Stone 340776 Roan Chrystaline V49-562E Roan
			Nellie 8th 614634 Red	Baron Lavender 387164 Roan Nellie 6th 614633 Red
		Golden Wreath 17th V57-593E Roan	Willie Campbell 646486 Red	Royal Victor 93286 Roan Pride of Rothes 803957 Red
			Briar Bud V57-593E Roan	Spion Kop 266466 Red Golden Wreath 7th V46-409E Roan
Dam	Newton Molly 2nd 650063 Roan	Newton Crystal 340775 White	Opal Stone 340776 Roan	Corner Stone 150676 Roan Orchid Blossom V45-468E Roan
			Chrystaline V49-562E Roan	Crystal Star 340772 Roan Lady Fragrance 9th V49-8222E Red
		Lady Molly 650062 Red	Corner Stone 150676 Roan	Touchstone 149631 Red and White Butterscotch V41-395E White
			Lady Madge 650060 Red	Lord Chamberlain 342978 Roan Lady Maud 650061 Red

unquestionably proven by the results obtained from the various matings in Table III. The question logically arises, why will a cross between red and black produce no roans? The reason is apparent when it is considered that red and black are genetically, as well as practically, true allelomorphs, resulting in complete dominance of black in the heterozygote. Which in turn will separate out in the second generation in the definite Mendelian ratio of three dominants to one recessive. This has been proven too often to need further discussion. It will serve, though, to show that the red of the Short-Horn may be often associated with the roan extension factor (E), but its presence will not be proved as it will not be brought to light in the phenotype.

Many of the apparent contradictions which occur in the various color matings of Short-Horns can be eliminated if it is assumed that red-and-white in the Short-Horn is not caused by the introduction of an extension factor entirely different from roan (E), but is really produced by the total absence of E and can be represented as (e). When this occurs in the presence of a heterozygous condition for red (R) a red-and-white animal is produced.

A logical basis has now been established for assuming genetic formulae for the various phenotypes, viz:

$$\text{Red} = \begin{cases} \text{RRee} \\ \text{RREE} \\ \text{RREe} \end{cases}$$

$$\text{Roan} = \begin{cases} \text{RrEE} \\ \text{RrEe}^{6} \end{cases}$$

$$\text{White} = \begin{cases} \text{rrEE} \\ \text{rrEe} \\ \text{rree} \end{cases}$$

$$\text{Red-and-White} = \begin{cases} \text{Rree} \end{cases}$$

The average mathematical possibilities of segregation from all possible mating combinations are given in Table III.

Apparent Contradictions Explained

Apparent contradictions are not so great as would seem at first glance; a comparison of theoretical possibilities with actual recorded results are given in Table III. It is obvious that the greatest source of error is the registration of red individuals. The recording or twelve per cent red-and-white, three per cent roan and one per cent white from this mating is sufficiently close to the theoretical possibilities to be within the limits of probable error. One or both the parents in these cases must have been genotypically red-and-white, but the pattern in the phenotype showed so great a preponderance of red that the individual was recorded as a red (see Figure 5).

The appearance of such individuals as *Rosewood Radium*, which shows a phenotype carrying both roan and pied pattern, can be explained by assuming they have a genetic makeup of (RrEe), with respect to the colors in question. A true roan of the genetic form (RrEE) is shown in Figure 4. On this hypothesis if mated to (RrEE) he would sire no true red-and-whites of the formula (Rree).

Theoretically a true red-and-white (Rree) such as is shown in Figure 7, crossed on (Rree) cows will produce no roans. Actually between five and ten per cent roans are recorded as resulting from matings of red-and-white on red-and-white. This is possible, when it is considered that animals having the zygotic formula (RrEe) may be recorded as red-and-white. Matings of (RrEe) and (Rree) would allow theoretical possibilities of twenty-five per cent roans. In figuring the percentages in Table II no allowance could be made for this probable source of error,

[6] RrEe is usually recorded as roan, as the American Short-Horn Association rules that an individual may be recorded as a roan if roaning appears on any part of the body. However, no doubt many RrEe individuals are recorded as red-and-white.

because it would seem unlikely that (Rree) and (RrEe) would occur in equal ratio. In fact, the preponderance of data shows that whenever possible (RrEe) individuals are registered as roans because of the greater popularity of this color over red-and-white.

Practical Aspects

1. The crossing of red on white will both theoretically and actually give the highest percentage of roans. Crossing roan on white will give the next highest percentage of roans. Red on roan, red-and-white on roan, roan on white, and roan on roan will all give about the same percentage of roan calves, approximately forty per cent.

2. To produce a strain of roan Short-Horns which will breed true for roan seems impossible from both a practical and theoretical standpoint.

3. A few isolated cases should not be used as a guide or to draw conclusions from. Several hundred cases should be traced to come to any definite conclusion.

4. Color pattern seems in no way to be correlated with sex in Short-Horns. A red bull crossed on white cows will produce as many roans as a white bull on red cows. Sufficient individuals to establish a fair average must be used.

5. Genetically there are three kinds of red and three kinds of white Short-Horns. This will account for many of the apparent contradictions in Short-Horn color mating.

6. Pure red on pure red will produce only red. Pure white on pure white will produce only white.

7. White in Short-Horns is due to the total absence of any color factor.

8. Red is the only real basic color in Short-Horns.

9. Red-and-white is due to a dilution of the red color factor, in the absence of the roan extension factor.

10. Roan is not a separate color, but is a blending of red and white due to the presence of an extension factor in the germ cells of one or both parent types.[7]

Table I. *The relative proportions of the various recognized colors of Short-Horn cattle in the United States at three different periods.*

Data for the years 1895-1914, inclusive, is taken from Plumb's *Types and Breeds of Farm Animals,* by permission of Professor C. S. Plumb. That for 1921 was compiled by the author.

Color	1895-1903 Number	Per cent	1910-1914 Number	Per cent	1921 Number	Per cent
Red	4,943	49.43	15,085	62.85	4,959	49.59
Red and White	2,748	27.48	3,540	13.93	1,114	11.14
Roan	2,034	20.34	5,072	21.13	3,532	35.32
White	275	2.75	503	2.09	395	3.95
Total	10,000	100.00	24,000	100.00	10,000	100.00

Table II. *Percentage of Color Segregation in the Zygote.*

		Red	Red and White	Roan	White
1. Red × Red =	{RREE, RREe, RRee} × {RREE, RREe, RRee} =	100	0	0	0
2. Red × R. and W. =	{RREE, RREe, RRee} × Rree =	50	25	25	0

[7] The author wishes to acknowledge the assistance and co-operation given by the American Short-Horn Breeder's Association through their secretary, P. K. Groves. Also to the assistance given by Mr. A. W. Lathrop and Mr. Herbert Comstock, of Syracuse University. To the many breeders and herdsmen consulted the author wishes to express his appreciation and thanks.

Table III. [1] *Segregation Table of Short-Horn Colors. Tabulated from Matings Traced in the American Short-Horn Herd Book. A Comparison of Actual Recorded Results with Theoretical Possibilities.*

Matings	Number Traced	Red: Recorded %	Red: Recorded No.	Red: Theoretical %	Red: Theoretical No.	Red & White: Recorded %	Red & White: Recorded No.	Red & White: Theoretical %	Red & White: Theoretical No.	Roan: Recorded %	Roan: Recorded No.	Roan: Theoretical %	Roan: Theoretical No.	White: Recorded %	White: Recorded No.	White: Theoretical %	White: Theoretical No.	Total %	Total Number
1. Red × Red	2,567	84	2,156	100	2,567	12	308	0	0	3	77	0	0	1	26	0	0	100	2,567
2. Red × Red-and-White	446	47	210	50	223	31	138	25	112	20	89	25	111	2	9	0	0	100	446
3. Red × Roan	3,218	50	1,609	50	1,609	10	322	8	257	39	1,255	42	1,352	1	32	0	0	100	3,218
4. Red × White	1,743	1	17	0	0	14	244	25	436	83	1,447	75	1,307	2	35	0	0	100	1,743
5. Roan × Red-and-White	117	22	26	25	29	14	16	17	20	51	60	33	39	13	15	25	29	100	117
6. Roan × Roan	2,616	24	628	25	654	8	209	8	209	45	1,177	42	1,099	23	602	25	654	100	2,616
7. Roan × White	342	1	3	0	0	6	20	7.2	25	47	161	42.8	146	46	158	50	171	100	342
8. Red-and-White × R. and W	129	31	40	25	32	54	70	50	65	6[a]	7	0	0[a]	9	12	25	32	100	129
9. Red-and-White × White	321	1	3	0	0	18	58	25	80	48	154	25	80	33	106	50	161	100	
10. White × White	186	1	2	0	0	0	0	0	0	1	2	0	0	98	182	100	186	100	186
Total	11,685	262	4,694	275	5,114	167	1,385	165.2	1,204	343	4,429	284.8	4,134	228	1,177	275	1,233	1,000	11,685

[1] In figuring the percentages given no fractions were considered, e. g., in figuring white by white for red offspring, two individuals recorded as red were found ; this is listed as 1 per cent. In roan by white, three reds were found recorded; this was also listed as 1 per cent out of 342 matings.

[a] All these are entirely within the limit of probable error. The production of roans from red-and-white on red-and-white is caused by individuals of genetic constitution (RrEe) being registered as red-and-white.

3. Red × Roan =	RREE, RREe, RRee × RrEE, rree =	50	8	42	0
4. Red × White =		0	25	75	0
5. Roan × R. and W. =	RrEE, RrEe × Rree =	25	17	33	25
6. Roan × Roan =	RrEE, RrEe × RrEE, RrEe =	25	8	42	25
7. Roan × White =	RrEE, RrEe × rrEE, rrEE, rree =	0	7.2	42.9	50
8. R. & W. × R. & W. =	Rree × Rree =	25	50	0	25
	RrEe × Rree =	25[a]	25	25	25
9. R. & W. × White =	Rree × rrEE, rrEe, rree =	0	25	25	50
10. White × White =	rrEE, rrEr, rree × rrEE, rrEe, rree =	0	0	0	100

[a] Such individuals as *Rosewood Radium* 512686 are probably of the genetic constitution of RrEe, with respect to color, and could be registered as red-and-white.

HUMAN CUCKOOS AND HEDGE SPARROWS[1]

The cuckoo lays its eggs in the nests of other birds, as we all know; and the little cuckoos aid their unnatural mother in her questionable designs by shouldering out from the nest their still smaller foster brothers and sisters. The cuckoo, moreover, in order to make her own egg less noticeable when she lays it, at the same time robs the nest she is invading of one of its eggs and eats it; thus, if I may so describe it, getting a free meal at the public expense. The point is, however, that these immoral birds increase the amount of care given to each of their young ones by delegating the whole of their responsibilities as parents to several other birds. Now, if natural selection in regulating fecundity is, as it were, only looking to the deaths which occur among adults, we should expect to find nothing unusual in the matter of egg-laying among cuckoos. But if, as I have suggested, fecundity is regulated in accordance with the amount of parental care available for the young, we should expect to find the cuckoo laid more eggs than the nightjar or any other closely related bird with more respectable habits. I confess that I was pleased to find that the cuckoo may lay as many as twenty eggs while the nightjar lays only two.[2] It is even more interesting to note that the number of eggs which the cuckoo

[1] Excerpted from an article by Major Leonard Darwin. "Observations on Fecundity, in the *Eugenics Review* for January, 1923.

[2] The evolutionary results of the cuckoo adopting these methods must have been somewhat as follows. The size of the family at first increased considerably, the size being measured at the time when the young birds became independent of parents or foster parents. This must have resulted in an increase in the cuckoo population. This in turn led to a rise in the death rate, until the size of the family, if measured by the number of offspring who themselves became parents, again fell to two, no more or no less; that is assuming the population to become stationary. See *The Cuckoo's Secret.* E. Chance. Sidgwick & Jackson. 1922.

actually does lay depends on the number of nests which are available, that is, on the amount of delegated parental care on which she can rely. Again, those fish which have no parental cares produce an enormously greater number of progeny than do those fish which look after their young. These facts seem to confirm my theoretical suggestions.

Thus far, we have been dealing with theory and fact, and now I ask you to follow me for a little in the path of imagination. Shakespeare, generally a sound guide both in fact and fancy, tells us that the hedge-sparrow is a bird whose nest is often invaded by the cuckoo.[3] And I cannot but wish that Shakespeare were here to tell us what would happen if the cuckoo and the hedge-sparrow became as good and as wise as human beings. Would cuckoos see the errors of their ways, and at once begin building their own nests? That is asking too much—from cuckoos. Would they perceive that, if they invaded too many nests, there would be an insufficiency of hedge-sparrows for their purposes in the distant future? I doubt it, for a cuckoo will always remain a cuckoo. Then as to a wise and good hedge sparrow, no doubt it would at once perceive that the cuckoo's egg was a changeling for one of its own. But would this virtuous bird think it wrong to eject the ugly intruder? And, if so, would she limit the size of her family so as to be able to give from the first undivided attention to her uninvited foster child? I do not know. I leave it to you to answer these difficult questions. And, in conclusion, I will only express the hope that, when you hear the cuckoos singing in the spring, the following four questions may recur to your minds. In the first place, have we not now many human cuckoos living in our midst; that is, persons of low morals and poor intelligence, endowed with the natural capacity for producing large families, the main object of whose life seems to be to throw the burden of rearing their numerous offspring on to the shoulders of others? Have we not also among us noble-minded but mistaken human hedge-sparrows; that is, persons who, for the sake of easing the strain on well developed but unscrupulous human cuckoos, are ready to sacrifice all their own chances of becoming parents of children of their own kind. Again, in looking to the future of our race, ought we not to consider quality rather than quantity. Lastly, for married couples designed by nature for the task, is not one of their highest duties on earth to take their part in peopling the world with descendants hereditarily endowed with noble qualities?

[3] Shakespeare was in truth a little too hard on the cuckoo.
"The Hedge-Sparrow fed the cuckoo so long
That it had its head bit off by its young."
—*King Lear* I, 4.

Biology and Heredity

Grundriss der Allgemeinen Zoologie fur Studierende, by Dr. Alfred Kuehn, Professor of Zoology and Comparative Anatomy in the University of Goettingen. Pp. 210. 170 illustrations. $1.10. Leipzig. George Thieme, 1922.

This well-organized introduction to general biology goes into some detail on Mendelian heredity, even to the point of describing linkage and crossing-over. The last section deals briefly with species-building. After pointing out that "pure lines" are artificial products of breeding, the author insists that the species is a "natural genetic unit," because of the free interbreeding of its members in a state of nature. —P. P.

EVOLUTION OF COMPOUND LEAVES IN WALNUTS AND HICKORIES

Variations Showing That Lateral Leaflets Correspond to Stipules of Bud-Scales

O. F. Cook

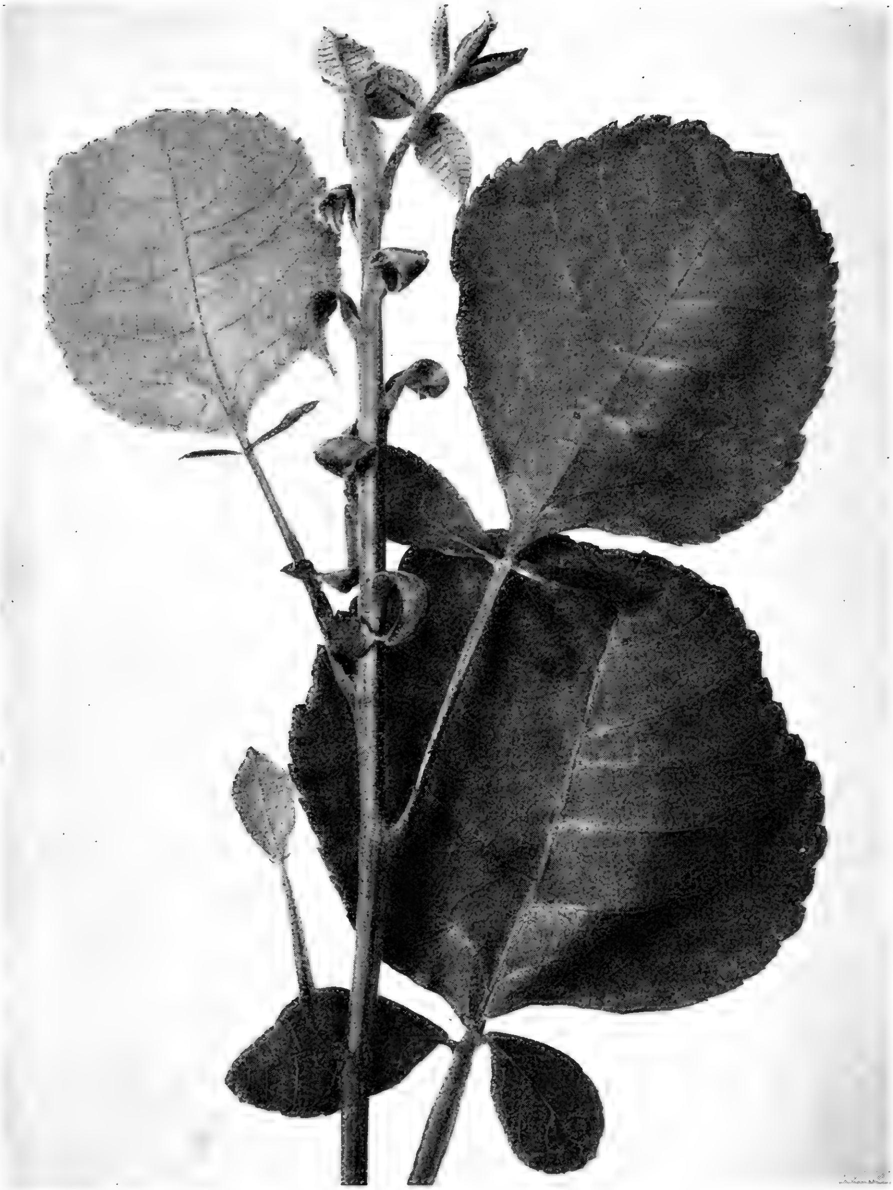
U. S. Department of Agriculture, Washington, D. C.

Unusual forms of leaves, intermediate between the bud-scales and the normally developed foliage, occur in several species of Juglans and Hicoria, including *Hicoria pecan,* and may throw light upon the structure and evolution of leaf-forms in this group of plants. Such aberrant leaves have been observed in several localities, and apparently are more frequent on trees growing in rather unfavorable conditions, or where the trees have been injured so that latent buds develop out of season.

Reversion may be defined as the expression of characters that normally are latent, and such characters may contribute to "bud-mutation" or other forms of vegetative variation. Though bud-scales are reckoned as specialized leaves, some of the characters of bud-scales may be primitive, as representing earlier stages of foliar evolution, of the period when the ancestral plants adapted themselves to seasonal changes that made bud-scales necessary.

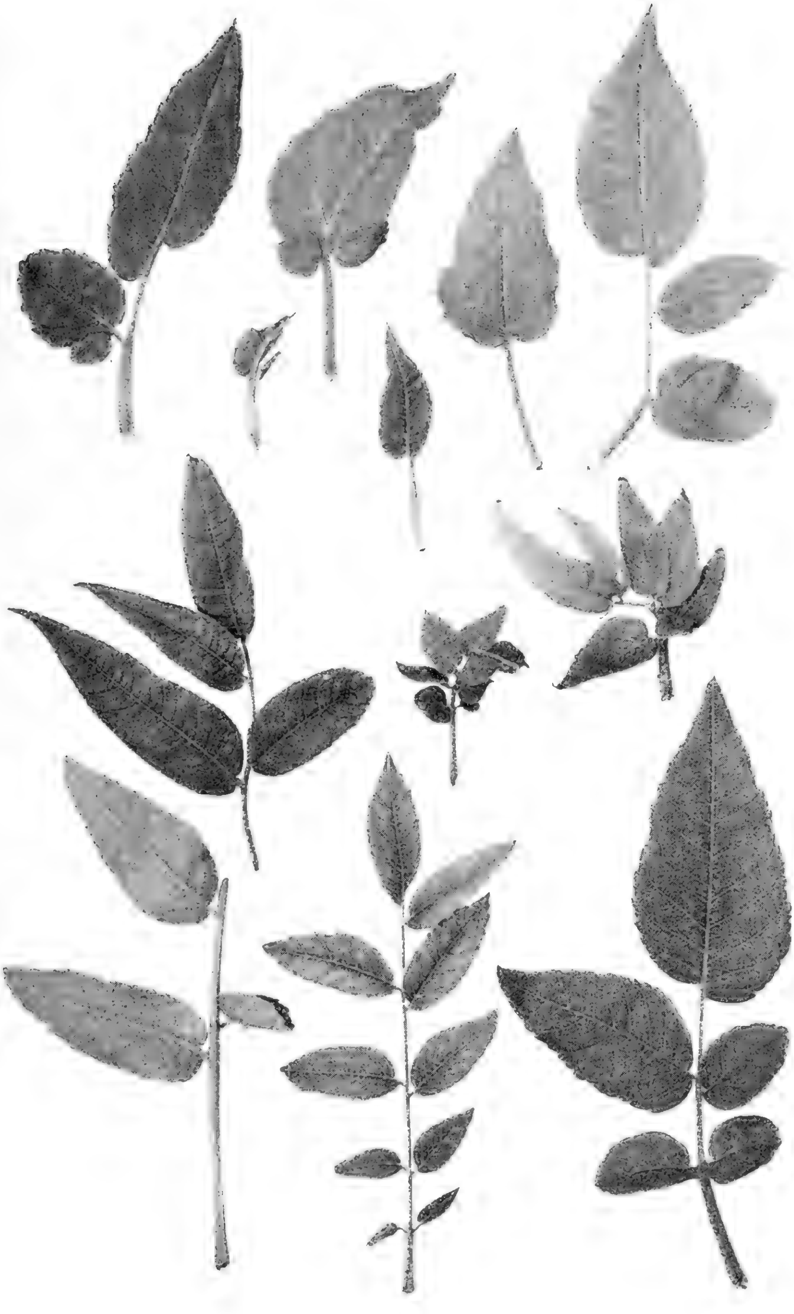
The study of leaf-forms should not be restricted by the idea that leaves are mere appendages of the stem or axial system, as formerly assumed by many writers on plant anatomy. The axis of the higher plants is not a simple structure but an aggregation of vegetative internodes, each internode representing a part of a metamer or structural unit of a compound organism. Some of the metamers are not represented by vegetative internodes, as bud-scales, bracts, petals, stamens and pistils. The plant body as a whole is a colony of diversified metamers, so that each joint or internode with its leaf or leaf-equivalent is a distinct morphological unit. The development of the plant is shown by a succession of internode individuals of different forms, produced one from another. The jointed, internodal structure of the plant, and the evolutionary significance of different forms of leaves on successive internodes, were recognized clearly by Goethe in his poem on the evolution of plants, published in 1790.

The modern evolutionary study of homology began with Goethe, who connected the two ideas of structural correspondence and community of descent. "The same organ," as Goethe said, "which on the stalk has expanded as leaf and taken a manifold diversity of form, now contracts itself in the calyx, expands again in the petal, and contracts in the sex-members, to expand finally as fruit." The need of a general word was noted, "wherewith we could designate this so variously metamorphosed organ, and compare all of the manifestations of its form." Although Goethe's view of the structural relations was condemned by some botanists of the last century as a "wildly absurd theory," it now is generally accepted, and such terms as internode, metamer and phytomer are in use as names for the "metamorphosed organ." In the writings of Goethe the diversities of the internode



METAPHANIC VARIATIONS OF HICKORY LEAVES

FIGURE 9. Late shoot of hickory, developed in partial shade at Lanham, Maryland, in August, 1922, with expanded bud-scales functioning as leaves. A series of eight internodes producing intermediate forms of leaves, followed by eight shorter internodes with somewhat enlarged bud-scales, at the end a young leaf of the normal compound form, with only the lowest pinnae expanded. The last bud-scale, standing nearly erect, is somewhat more leaf-like than the others, showing a larger blade rudiment and having the lateral wings of the base produced above into diverging stipule-like organs, which also appear in more rudimentary form on the smaller or more normal bud-scales. The leaves have winged bases like the bud-scales, and some of the wings are produced above into small, delicate, transparent, stipule-like appendages, closely similar to those of the bud-scales, while other leaves show larger stages of development of the stipular appendages, including broad pinnae not unlike those of the normal compound leaves. (Natural size).



PRIMITIVE LEAF-FORMS OF WALNUT

FIGURE 10. Leaves from small late shoots of "Royal" walnut at Bard, California, September, 1922, showing a range of forms, from simple to compound. Some of the smaller leaves have the base distinctly winged and with distinct stipules, or with a stipule on one side opposite a broad pinna. At the upper right-hand corner is a leaf with two stipules on one side, with broad pinnae opposite, showing that stipules are reduplicated and are morphologic equivalents of pinnae. (Natural size).

members served at once as an illustration and a proof of the development of divergent forms from the same ancestral type. The same idea of metamerism was applied even to the higher animals, in comparing the skull bones with the vertebrae.

Though the first thought in homology is of structural correspondence, evolution is the fundamental idea. A difficult or doubtful homology involves the idea of divergent paths of evolution, so far separated that the present diversity has obscured the original identity. But by tracing the evolutionary paths something may be learned of the original structure and of the intermediate stages of development. For progress in the study of heredity as well as in breeding and selection, it is desirable to know the evolutionary status of the characters, so that reversions and pathological abnormalities may be distinguished from normal diversities or progressive changes of characters.

The most primitive forms of leaves may have resembled the cylindrical sheaths of Equisetum, or may have arisen as expanded, sterilized stamens, which is the usual interpretation of the petals and sepals. Different origins may be indicated by the completely different types of leaves that occur on some plants, as the junipers and eucalypts. It is of interest to trace corresponding developments of leaf-structure in the several families of plants to see how far such structural correspondences, or homologies, can be established.

Two Primitive Leaf-Elements

Instead of the customary division of the leaves of higher plants into three structural elements, stipules, petiole and blade, two primary elements may be recognized, the foot and the blade. The foot represents a primitive sheathing leaf-base that encircled the next internode, while the blade is the expanded portion of the leaf, so variously developed in the different families of plants. Stipules and petioles, in this view, are secondary specializations. Stipules may be considered as segments or subdivisions of the primitive foot element, while petioles apparently are of two or more kinds, of different derivation and hence not strictly homologous. Some petioles represent a narrowed basal portion of the blade element, while others have developed by narrowing the terminal portion of the foot element. A distinct joint or pulvinus at the end of a petiole may indicate the primitive articulation of the blade element with the foot element.[1]

Stipules on Bud-Scales

Although stipules are supposed to be absent in the Juglandaceae, stipular elements may be recognized in the bud-scales, in rudimentary organs that correspond directly to the lower pinnae of the compound leaf. Reasons are found also for viewing the other lateral pinnae as reduplications of the lowest, stipular pair, so that only the terminal unpaired leaflet is left to represent the original blade element, corresponding to the simple leaves of seedlings and to simple leaves of other plants. If these homologies are correctly inferred, the evolution of compound leaves may be traced in this family, not through expansion and division of simple leaves, but through development and reduplication of the stipular elements. This interpretation need not be refused because in other families the stipules may have been suppressed or retained as merely rudimentary organs. (See Figures 9 to 14, with explanations describing several variations.)

[1] General Morphology of Leaves. *Journal Washington Academy of Sciences.* Some leaves may consist of an expanded foot, with the blade element entirely suppressed, or possibly never developed. See Arber, Leaf-base Phyllodes among the Liliaceae, *Bot. Gaz.* 69: 337. 1920.

Homologies of Stipules and Pinnae

If the walnuts and hickories had only one pair of lateral pinnae the relation of these to stipules might be more apparent. It would hardly be questioned that the base of the compound leaf, below the first pinnae, corresponds to the primitive foot, or sheath element, while the stalk of the terminal leaflet corresponds to the petiole of the simple leaves of hickory seedlings, or to the petioles of some of the plants that have simple leaves, as the peach, plum and apple. The correspondence is complete in the walnut and hickory bud-scales, where the leaf-base, or foot, takes a broad sheathing form, and is still obvious when lateral wings are shown in the intermediate forms of leaves, between the bud-scales and the fully developed compound leaves. Only in the large, adult forms of leaves, with the full number of pinnae, are there no traces of stipular wings on the leaf-base. Lubbock has noted the protection of the bud of the walnut by the "dilated base of the leaf-stalk" as a special feature, but the winged bases and stipules of the bud-scales and small leaves apparently were not observed. (See Figures 9, 10, and 14.)

The lowest pinnae of the intermediate forms of leaves also show special relations with the lateral wings of the petiole. In many cases, especially in the pecan, the wings of the leaf-base are wider above and run out upon the midribs of the pinnae. Moreover, many of the pinnae that have winged midribs are cut away at the base on one side, forming a characteristic broad notch, sometimes strikingly developed. The basal portion of such pinnae, where the lower side is cut away, may also show a strong curvature, or the entire lower pinnae may be curved downward, so that they appear quite different from the others. (See Figure 12.)

Pinnae Replaced By Stipules

Pinnae of the intermediate leaf-forms occasionally are replaced by small, transparent, narrowly-pointed organs, closely similar to those that terminate the lateral wings of the expanded bud-scales. No doubt these small organs would have been recognized as stipules if they occurred regularly in the normal leaves, instead of being developed into pinnae, and the wings suppressed. All degrees and stages of development are found between thin, narrowly-tapering, thoroughly stipule-like structures and fully developed lower pinnae, of the same size and shape as the others. The extent of foliar development of the basal organs seems especially variable. As shown in Figure 9, some of the stipule-like pinnae are very slender and delicate, and these may consist entirely of pale, semi-transparent tissue, or the lower side may be of thin, stipular texture like the wing of the leaf-base, while the upper side, above the midrib, has a narrow or broad band of green tissue, like that of the normal pinnae. Replacement of pinnae by rudimentary organs is not confined to the lowest pair as shown in Figure 9, or even to the second pair, as shown in Figure 14, but may occur with any of the lateral pinnae as shown in Figures 10 and 11.

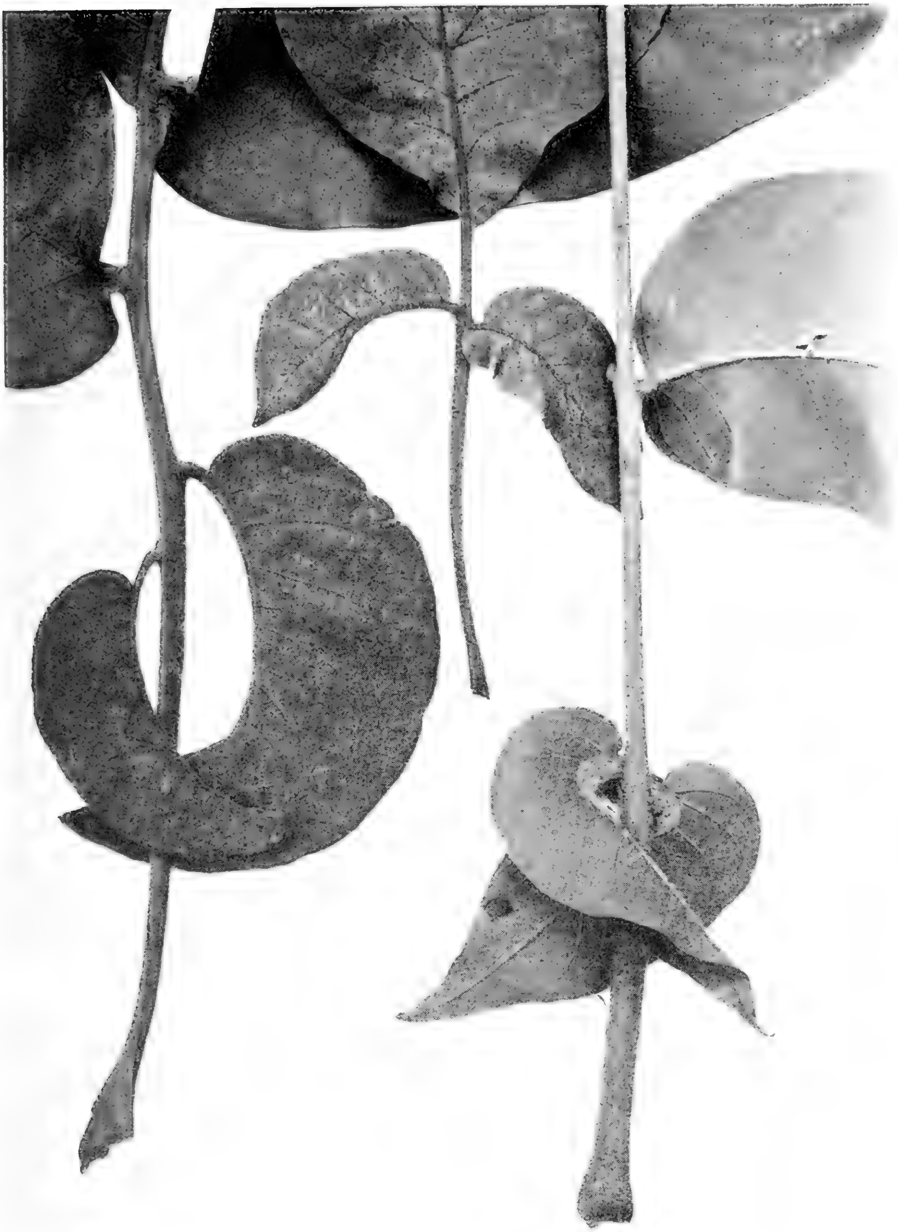
Development of Compound Leaves

With the lower pinnae thus appearing as homologous with stipules, a like origin and development from the primitive stipular element is indicated for the other pinnae, especially in cases of replacement of pinnae by small stipule-like organs and by more frequent occurrence of basal emarginations on other lateral pinnae, or on all of the lateral pinnae, as happens not infrequently in the pecan. Though no indications of lateral wings have been observed on the joints of the rachis, between the successive pairs of lateral pinnae, this is not to be taken as a reason for supposing that the upper pinnae are different from the lower, in view of the complete suppression of wings from the bases of the adult form of leaves.

Supposing that the other pinnae are of the same nature as the lowest pinnae,

WALNUT LEAF WITH PINNAE REPLACED BY STIPULES

FIGURE 11. A late-growth leaf of "Royal" walnut, at Bard, California, September, 1922, with an upper pair of pinnae replaced by small stipule-like organs. Other leaves of the same tree showed other pairs or single pinnae replaced in the same way, including cases of the uppermost lateral pinnae so replaced, which seems to prove that the small stipule-like organs are structural equivalents of the pinnae, and indicates the possible derivation of the pinnae through reduplication of stipules. (Natural size).



LOWER PINNAE OF PERSIAN WALNUT LEAVES

FIGURE 12. Intermediate leaf-forms of the Persian walnut at Chico, California, with the lateral pinnae reduced in number and of different forms. The small leaf in the middle has only one pair of lateral pinnae, and these unequal. The left-hand pinna of this leaf is cut away on the lower side for half its length, while the right-hand pinna has the leaf-web complete and of nearly equal width on both sides of the midvein. The lower pinnae of the left-hand leaf are strongly curved and completely one-sided, with no leaf-web at all on the lower, or proximal, side of the midvein. The right-hand leaf shows an even stronger curature of the basal pinnae, but only at the base where the wings of the leaf-base run out upon the pinna. (Natural size).

the compound leaf of the walnut family appears to have been developed, not by subdivision of the original simple leaf but by reduplication of the foot element, with its stipular elements, to form the several joints of the rachis and the corresponding pairs of pinnae. The number of pinnae is quite variable in this family, among the leaves of the same trees, with extreme reductions to one or two pairs of pinnae in the bud-scales and small adjacent leaves. Reduplication of stipules occurs in other families, including the Malvaceae. Some varieties of okra have four or more stipules, and the involucres in cotton and related genera may have been developed through reduplication of stipules. Although the usual forms of compound leaves do not appear in the Malvaceae, a complex structure may be indicated by the radial lobing.

In the walnuts and hickories, at least, we are brought to consider that the major part of the leaf, up to the insertion of the terminal pinnae may be derived from the primitive foot element, with only the terminal pinna and its petiole representing the blade element of a simple-leaved plant. Considering that the blade of the primitive leaf may have arisen as a specialized median appendage or lobe of the foot, the stipules may be reckoned as lateral lobes of the same foot element. Thus the foot would appear as a single primary element with one median and two lateral lobes, developed as blade and stipules. In some families only the blade has developed foliar, assimilative functions, in others the stipules also. In the walnut family the stipules as well as the median blade element have had a foliar development, no doubt at first merely supplementing the blade element, but eventually over-balancing and replacing the blade.

Nature of the Intermediate Leaf-Forms

A general tendency in the later evolution of the compound leaves is to equalize the terminal and lateral pinnae. The terminal pinna, instead of being much larger and broader than the lateral pinnae, as in the primitive and intermediate leaf-forms, is reduced to nearly the same size as the lateral pinnae. Indeed, the reduction of the terminal pinna often is carried to the stage of complete suppression, as occurs in some of the pecan varieties, and in some species of walnuts, including *Juglans californica,* the parent of the remarkable "oak" walnut mutation. In this the terminal pinna is regularly developed and the lateral pinnae reduced to two pairs, or replaced by small stipular organs like those of the bud-scales. (See Figures 13 and 14.)

When the terminal pinnae are reduced to the same size as the others, their only distinctive features are bilateral symmetry and the possession of a petiole, but occasionally the lateral pinnae also are stalked, as observed at Sacaton, Arizona, in many leaves of the Frotscher pecan. This may be considered as a further step toward equalizing the pinnae, with the lateral pinnae beginning to show a character that previously was confined to the terminal pinna. Likewise, the development of the rachis by intercalation of more numerous joints and additional pairs of pinnae may be considered as a reflection or imitation in the leaf of the jointed structure of the stem.

The evolutionary interest of such equalizing tendencies among the different parts of plants was first recognized by Leavitt, who considered such characters as having been transferred from one part of a plant to another, by a process which he called homoeosis. But if it be supposed that the characters exist potentially in all the parts of a plant, the idea of a transfer seems unnecessary, since the apparent transfers may result from changes in the expression of the characters. Such changes would account not only for different degrees of expression but also different combinations with other characters. In the words of East: "One must realize that each gene has many

effects on the organism, some of which are not easily discoverable." This is another way of saying that the problem of expression of characters should be separated from the problem of transmission. The "effects" may be changed by altering the expression-relations of the characters. To designate such variations, that show intermediate stages and combinations of characters, the word metaphanic has been suggested.[2]

Evolution Through Mataphanic Variations

Special evolutionary interest may be claimed for metaphanic variations, since the development of new somatic features may go forward through such changes in the expression of characters, without the need of supposing that definitely new characters have been formed in the "mechanism of heredity," which serves for the transmission of characters. Since many evolutionary changes could be explained by supposing that characters already existing have been readjusted or recombined in their expression, fewer fundamental changes in heredity would be called for, if metaphanic changes were recognized. No doubt many metaphanic variations are abnormal or degenerative, as when a loss of specialization results from parts becoming more alike, but some of the variations may be progressive.

An example of evolution that may be ascribed to metaphanic changes is the development of the jointed rachis of the compound leaves, which may be viewed as an intermediate expression or partial reflection in the leaf of the jointed, internodal structure of the stem. In the course of their development, the compound leaves of the walnut family have become more stem-like or branch-like, contrasting in this respect with other families where the tendency is for branches to become more leaf-like. In such cases as Phyllanthus, Zizyphus and Castilla the branches have not only the general form of compound leaves but also the temporary and deciduous behavior of leaves, through the development of a specialized joint or abscission layer at the base.

Cotton, coffee, cacao and many other plants are like Zizyphus in having two or more distinct forms of branches. Intermediate forms of branches may occur in abnormal cotton plants, and such branches may be completely sterile like hybrids of diverse species. In less abnormal cases flower-buds may be formed at each point of the intermediate branches, but all the buds are aborted and shed before the fruiting stage is reached, as in the so-called "bull-stalks" of Sea Island cotton. Sterility, however, depends to some extent on the external conditions, since a few bolls may be set late in the season on plants that have aborted all of the earlier buds.[3]

Metaphanic variations show that the problems of adaptation are not merely external, in relation to the environment, since there also are problems of internal adjustment, or relations of the parts to each other. With the principle of metaphany recognized, a wider view is possible of the relations of the characters or parts of an organism to each other, since parts or characters of independent origin may be combined or rearranged through metaphany. The metaphanic variations show a general lability and interplay of the characters in their expression relations, which are significant alike for heredity and evolution.

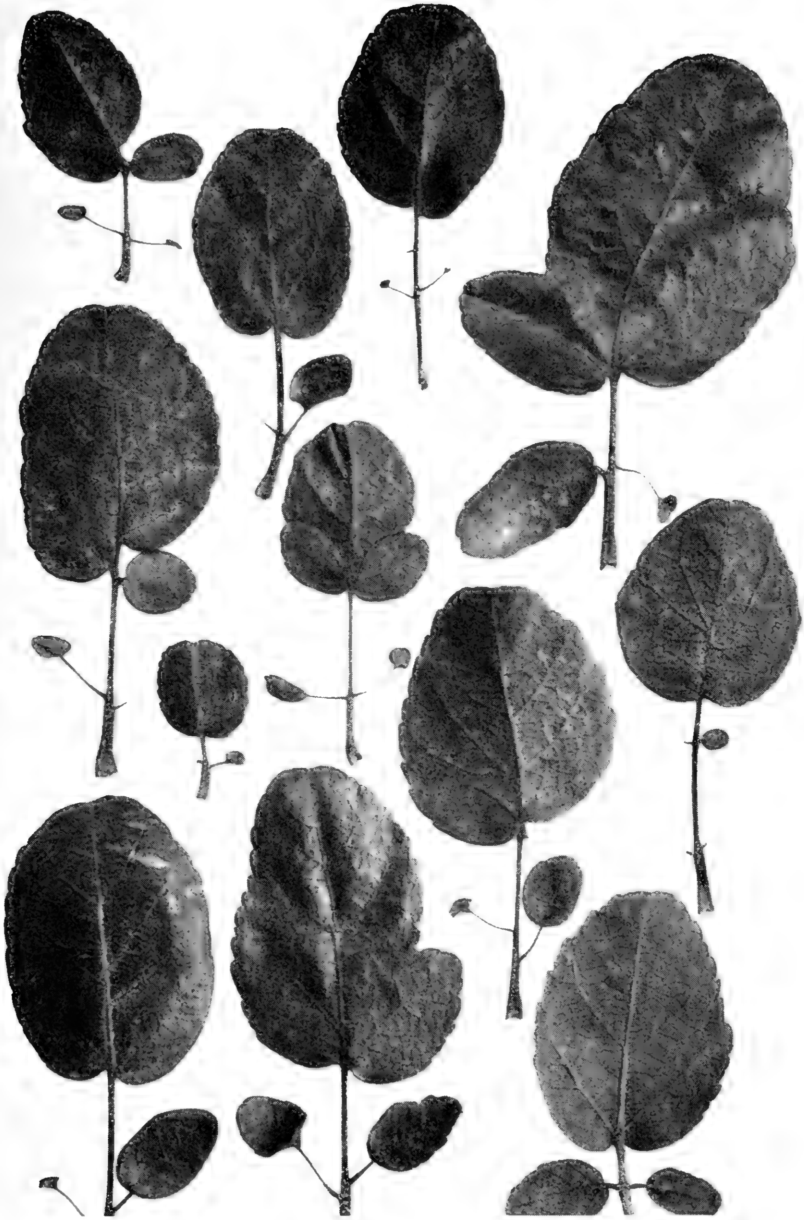
Metaphany may be defined briefly as internal hybridism, resulting in the formation of intermediate structures, so that specialization is reduced in the sense that metaphanic variations render

[2] Brachysm, A Hereditary Deformity of Cotton and Other Plants, *Journal of Agricultural Research*, III. 387. February 15, 1915.

[3] See, Causes of Shedding in Cotton, *Journal of Heredity*, 12:119, May, 1921. Also, Dimorphic Branches of Tropical Crop Plants, *Bul.* 198, Bureau of Plant Industry, U. S. Department of Agriculture, 1911.

THE OAK-WALNUT MUTATION

FIGURE 13. The oak walnut is a peculiar mutation of the native California walnut (*Juglans Californica*), so distinct from the parent type as to have been described as a distinct species, *Juglans quercina*. When first discovered it was supposed to be a walnut-oak hybrid, on account of the peculiar shape and the thick leathery texture of the leaves. (See BABCOCK, E. B., A New Walnut, *Journal of Heredity*, Vol. VI, p. 40). Some of the leaves are simple with only one pair of lateral pinnae, but most of the leaves have two pairs of pinnae. The small size of the leaves and the reduced number of pinnae may be explained by analogy with the intermediate or bud-scale leaves of other members of the family, but complete suppression of the normal compound leaves is remarkable. A variety of the Persian walnut has also been described under the name *Juglans monophylla* to which the California oak-walnut may be analogous. A tree of the oak-walnut at the U. S. Plant Introduction Garden at Chico, California, bore a large crop of ripe fruits in September, 1922. Many of the fruits were twinned, mostly with separate nuts, but in some the shells of the two nuts were grown firmly together, as shown at the top of the photograph. (Natural size).



LEAF FORMS OF THE OAK WALNUT

FIGURE 14. Showing replacement of pinnae by small stipule-like organs, which occurs frequently in leaves of the oak walnut. In some cases both pairs of pinnae are replaced, either by simple stipules, or by slender, stipule-like organs that serve as pedicels for very small pinnae which are quite variable in form, oval, circular, or cup-like. The cup-like pinnae, or "ascidia," apparently are formed by union of the basal margins below the point of attachment of the leafy portion of the pinna with the stalk. Formation of these cup-like pinnae may indicate a backward growth of the leaf-web, from the apex toward the base along the midvein. Note that in several of these leaves one or both of the lateral pinnae have united more or less completely with the terminal pinna as in the lower right-hand leaf. Also compare this leaf with Figure 9 to observe the close approximation with the bud-scale leaves of hickory.

the affected parts less different than they previously were, though such changes may give increased utility to particular organs, and thus increase the efficiency of the organism. With such variations occurring rather frequently, it may be considered that the adaptive possibilities of the different combinations of characters are being tested automatically in relation to the environment, and that under natural conditions the species has the benefit of any desirable modifications that arise. The liability to metaphanic variations enables the species to conduct, as it were, a continual trying-out of adaptive possibilities, not only of all of the existing characters, but of all of the stages and degrees of character-combinations.

For purposes of evolutionary study, two kinds of metaphanic characters or expression relations may be recognized, those that may be considered as more primitive, or in the nature or reversions to earlier stages of development when structures were less specialized, and those that may be considered as recent stages or of possible significance in future evolution, if successful combinations are made of characters not previously associated. While the intermediate or bud-scale leaves of the walnuts and hickories must be considered as reversions to more primitive forms, an advance appears to have been made in building up the compound leaves, by a jointed structure like the stems developing in the leaves and branches. It is desirable to have a general name for the intermediate variations while the evolutionary status of such characters is being determined.

Meeting of the Eugenics Research Association

The program committee of the Eugenics Research Association has set Saturday, June 16 as the date for the annual meeting this year. As usual, it will be held at the Eugenics Record Office, Cold Spring Harbor, Long Island, N. Y.

Judge Harry Olson, of Chicago, will deliver the presidential address on "Crime and Heredity."

It is announced that "the 1923 meeting will have to decide several important matters of policy, such as that of incorporation, of planning definite scientific investigations, and the cooperative division of the field logically covered by eugenics societies, with particular reference to research, on the one hand, and education on the other."

The executive committee announces that on February 10 it "voted a small stipend to Dr. Harrison R. Hunt to aid in his studies on 'War and Eugenics.' This marks the first official appropriation for specific research made directly from the treasury of the society."

TWIN AND TRIPLET PEACHES

C. H. Connors

New Jersey Agricultural Experiment Station, New Brunswick, N. J.

THE OCCURRENCE of double fruits on peach trees is not uncommon in any season, but certain seasons seem to bring forth larger numbers. Blake and Connors[1] reported the large numbers found in the experimental orchards at Vineland, N. J., in the season of 1915. These were not in such large proportion as those reported by Karper.[2]

Multiple fruits may occur by two methods, and by combination of these two methods. The peach more frequently than not sets three buds at a node, two blossom buds with a leaf bud between. In some cases, three and four flower buds are formed at a node. Frequently, twin flowers are formed, originating from a single bud and upon the same pedicle (Fig. 15). The two conditions are not easily confused. The stigmas of the twin flowers usually become receptive simultaneously, and may be pollinated at the same time. Given normal conditions following pollination, the ova will be fertilized and the fruits will develop at approximately the same rate, resulting in more or less symmetrical twin fruits.

The second method is by multiple pistils. As is well known, peach blossoms have normally only one pistil, but Figure 16 depicts blossoms having one, two, and three pistils, and Figure 15 shows immature fruits developed from such blossoms. The writer has never seen more than three pistils in the blossoms of the edible peaches, but the ornamental double-flowered forms have from one to six pistils. In the course of emasculating and pollinating more than 10,000 peach blossoms during the spring of 1922, opportunity was given to study the development of multiple pistils. All gradations were found. The first step appeared to be fasciation of the stigma, then a fasciated style; the next gradation appeared to be two stigmas on a fasciated style, then two stigmas and styles upon a fasciated ovulary and finally, two distinct pistils. Very frequently, however, one pistil is less developed than the other, and probably is never pollinated, resulting in either a single fruit or else the pericarp develops very slowly, resulting in some of the odd forms.

By combining these two forms, a twin flower, one of the members of which is double pistillate, might give a triple fruit as well as a single flower with three pistils; twin flowers with both members double pistillate might give quadruple fruits; and so on.

In the first figure of the paper by Karper, what appears to be a quadruple fruit, judging by the illustration, is really not a quadruple fruit on a single pedicle, but seems to have been formed from the usual three bud formation, in which the blossom buds each developed into twin blossoms, resulting in double fruits, while the leaf-bud failed to develop, allowing the two double peaches to come into intimate contact in such a way that a quadruple fruit seemed to be formed.

The range in development attained in double fruits is shown in Figure 17 in which six specimens are shown whole and in section. It will be noted that in the case of one fruit, at least, the growth appears to be purely vegetative. Possibly the ovum was not

[1] Blake, M. A., and Connors, C. H. Odd Forms of Peaches. *N. J. Stas. Rept.* 1916, p. 78.

[2] Karper, R. E. Compound Fruits of the Peach Resulting from Multiple Pistils. *Journal of Heredity*, xii:402-406. 1921.

TWINS AND TRIPLETS

FIGURE 15. Twin peaches are formed in two ways, (1) from twin flowers (center row), and (2) from a single flower having twin pistils. Triplets are produced either by a combination of these two methods—by twin flowers one of which has double pistils (d and e), or by a single flower with three pistils (b and c, top row). Flowers with more than three pistils are very rare, and quadruplets are in reality double twins, twin double-pistilled flowers producing the quadruple form (a, top row). On the bottom row is shown how twinning occurs by the formation of a double flower. Normally three buds are formed at each node, a leaf bud and two flower buds, which produce two separate fruits, as at (a). Sometimes a double flower is formed in place of one of the single ones. Twin peaches from such double flowers are usually of about the same size, while those from double pistils are unequal in development.

SINGLE, DOUBLE, AND TRIPLE PISTILS

FIGURE 16 The twins and triplets formed from such pistils are usually markedly different in size, as shown in Figure 17. The triple-pistilled flowers are shown at the right and left of the picture. One pistil is considerably shorter.

fertilized, but the fruit was able to develop slightly because of its close connection with the larger fruit.

There is considerable variation among varieties in the setting of these multiple fruits. Of the list given by Karper, Mayflower, Alton, Japan Dwarf Blood, and Hiley belong to the Chinese Cling

TWIN FRUITS ENTIRE AND IN SECTION

FIGURE 17. Fruits from a twin flower are shown in the lower right-hand corner. The five other twins were produced by flowers with double pistils and development has been very unequal. In one case, at least, growth of the second fruit appears to have been purely vegetative.

group; and in our observations of 150 to 200 varieties, the varieties of this group rarely form multiple fruits. The remainder are of the so-called Persian or Crawford group or are inter-group hybrids. In normal years, more double fruits are seen on varieties such as Foster, St. John and other closely related varieties of the Persian or Crawford group, and our observations show that the majority of these are probably formed from twin flowers rather than from single flowers with double pistils.

The causes of this phenomenon may be many. The tendency seems to be hereditary among a certain group of varieties. The occurrence would seem to be due to environmental conditions and any environmental factor or combination of factors which would tend to bring about doubleness would cause this multiplication.

When To Marry

The age at which one should marry presents a problem with so many sides that any simple solution of it is out of the question. But it is a question on which every one holds a definite opinion; so the *Umschau*, a German weekly devoted to popular science, is likely to find many contestants for prizes aggregating 40,000 marks, which it offers for the best brief essay on the subject. It desires that the question be considered from the points of view of genetics, hygiene, psychology and psychiatry, either collectively or singly. Judges of the contributions are Max von Gruber, Professor of Hygiene in the University of Munich, and one of the leaders of the eugenics movement in Germany; Valentin Haecker, a well-known geneticist at the University of Halle; and H. Bechhold, of Frankfort am Maine, editor of the *Umschau*.

From France, at the same time, comes a partial attempt to answer the question, in a paper by Dr. Paul Godin, which occupies the leading position in the second number for 1922 of *Eugénique*, the organ of the French Eugenics Society. Dr. Godin's study, entitled "Eugénique et Puberté," leads to the conclusion that on the average, a woman is physiologically ready for marriage at eighteen and a half years, a man two years later. The data on which these conclusions are based are far from conclusive, however.

Lives of Fossil Animals

LEBENSBILDER AUS DER TIERWELT DER VORZEIT, by OTHENIO ABEL, Professor of Paleontology at the University of Vienna. Colored frontispiece and 507 text figures. Pp. 639. Jena, Verlag von Gustav Fisher, 1922.

Paleontology has played an important part in forming the general doctrine of evolution, and paleontologists have not hesitated to draw precise conclusions involving somewhat detailed points of genetics—conclusions which most geneticists have been inclined to challenge, on the ground that the fragmentary documents afforded by fossils are not detailed enough to warrant precise conclusions. Nevertheless, every contribution from the realm of prehistoric animals is welcome to the student of heredity, and the lavishly illustrated volume by Dr. Abel is particularly attractive. The author's plan is to give a detailed description of the life of ten different periods, regarding which the extant evidence is fairly abundant. Three of the regions considered are in the United States. —P. P.

A REVIEW OF REVIEWS

Of Madison Grant's

PASSING OF THE GREAT RACE

IT IS now six years since the first edition of Madison Grant's "Passing of the Great Race" attracted the attention of the reading public to discussions centering about heredity, and caused even at its inception, as scientific books go, considerable of a sensation. It was violently attacked. It was heartily commended.

Much of this controversy was evidently emotional in its origin, and now that the Great European War is a thing of the past it is easy to see that many of the hostile reviews were actuated by a feeling that Madison Grant was echoing the dangerous Germanic theories of Gobineau, Nietzsche, and Houston Stewart Chamberlain and was, perhaps, hooting a little at the then popular slogan: *Make the World Safe for Democracy.* Some of the reviews were evidently personal resentments from individuals not belonging to the so-called Great Race. Another class of criticisms came from scientific men who deplored the absence of all footnotes and specific references, and felt that this book, even though it might be essentially true, had been written in a partisan spirit, and that many of the detailed assertions could not be substantiated by research data.

The present writer reviewed the second edition in something of the latter spirit, on the whole favorably, in *Science,* October 25th, 1918. Now that a new edition has appeared giving very complete references to authorities, it is only fair to give the book another review. It seems the references were left out intentionally in order, as the author told the present reviewer, "to get people to read the book." "You scientific men are too modest. You lumber up your books with references to authorities. The reading public cares nothing for the scientific names; their eyes and minds are confused by the foot notes. They want to read directly from their author."

This seems to the reviewer to be worth putting down in print in this, a scientific journal, since all scientists have to consider the art of presentation, and naturally wish their researches to be known, at least to someone besides themselves. Scientists enjoy foot notes, the names mean everything to them; but ultimately scientific knowledge has to be presented to the general public, and it is through just such readable and popular books as Mr. Grant's that this matter is accomplished.

The latest edition,[1] seventh printing, fourth edition, revised 1921, contains 263 pages of text and 176 pages of documentary supplement, all the references to authorities being placed in the appendix. Mr. Grant does not intend to lose any readers by stopping them in the text.

By taking the references one by one and turning to the indicated page and line the names of the authorities can be filled in. The present reviewer has done this for most of the book, writing the names in pencil on the margin. It appears that the major portion of the text is supported on good structure of researches and authoritative opinions.

There are nevertheless a good many assertions that appear exaggerated, and are at least statements that cannot at the present day be referred to any exact investigations, simply because mankind has been so tardy in recognizing the importance of the "proper study of mankind," and has not much

[1]Published by the Charles Scribners Sons, New York. Price $2.50 net.

utilized in any objective spirit the immensely valuable record we commonly call "history." One point at least can be certainly made, that not one of the hostile reviewers has taken any point to point method of evaluation. They do not appear to be actuated by a desire for truth. For instance, such general assertions as the following are frequently found among the reviews for the most part written during the late European War: "All that can be said of some of the statements brought forward by Mr. Grant as scientific evidence of his thesis is that they are incorrect."—*London Times,* May 3rd, 1917.

The phraseology is "some of the statements," but unless the sentence is read very carefully it gives the impression that most of the statements are incorrect. This is the only sentence quoted by the *Book Review Digest* in its general summary of all important reviews for February, 1918. The mark minus (—) is placed against it. This is a good illustration of the sort of injustice that may be done a book when editors are war-mad. The *London Times* then attacked two comparatively unimportant and probably erroneous assertions of Mr. Grant. First, that the Nordics were killing themselves off in the Great War, and second, that human characters obey Mendelian laws during their hereditary descent.

The *Dial,* May 17th, 1917, said: "The science is so pure that it is altogether imperceptible." "This form of arrogance is not new in the history of civilization."

"Anti-Democracy" is the heading of the review in the *Athenaeum,* July, 1917. "It is an axiom with Mr. Grant —for he makes not the least attempt to prove it—that heredity is more than environment." (The present edition gives the references.) "We had thought that this species of race ecstacy, this enthusiasm for laying stress on the racial basis of European history, with which the name of Houston Stewart Chamberlain is associated, was going out of fashion even in Germany where it was introduced to give an appearance of scientific support to the position of the Junkers, and to bolster up the divine right of kingship. But that a writer in democratic America should give currency to these doctrines is passing strange." This review appears to be actuated by war-emotion.

In the *Unpopular Review* for October, 1917, we find a criticism directed against Mr. Grant's not giving greater credit to the French nation: "We are asked to believe that XIXth century democratic France was decadent; a glance at the roll of French fame for the last hundred years is sufficient reply. Perhaps Cuvier, Comte, Claude Bernard, Taine, Pasteur were all Teutons? Such an assertion in most cases is difficult to disprove. Renan, who was a believer in race, and a great admirer of Germany, gave his ethnic formula as "a Celto-Gascon mongrel, with a dash of Lappish blood" and added modestly: 'This ought to correspond to perfect imbecility.' Henri Poincare was a mathematician of rare genius; it is said that in the last years of his career he suffered from the solitude of the discoverer voyaging through strange seas of thought alone. We have a minute physiological description of him by Dr. Toulouse. This pioneer was an Alpine, a 'vile brachy'."

Such a paragraph illustrates very well the childish futility of attempting to settle generalizations in fields of history by citing a few instances. As a matter of fact, France has fallen behind during the last three generations very markedly in her production of scientists of international eminence as compared with England and Germany and quite beyond the expectation from changes in the total population. This assertion is based on statistical research the abstract of which was published in the *Psychological Bulletin,* February 15th, 1914.

A very unfavorable review appeared in *Vanity Fair* for October, 1918. It occupied a page and a half of this

popular journal. A large picture of Alexander Dumas appeared on one of the same pages—amusing coincidence. The writer of the review is an author of childrens' plays, literary essays, etc. He tells all who may wish to read that: "As for skull measurements the old-fashioned phrenologists dealt at least with Love, Ambition, Memory and other human qualities."

It appears from a review of reviews of this singularly provocative work, "The Passing of the Great Race," that the distinctly unfavorable criticisms were all published in other than scientific journals. Those in scientific journals were on the whole reasonably commendatory, though they did not regard it as a strictly scientific work. Favorable reviews appeared in the *New York Times* and also in the *Tribune*, January 13th, 1917; *Nation*, April 19th, 1917; *Nature* (London), August 23rd, 1917; the *Yale Review*, April, 1917; *Geographical Bulletin*, Philadelphia, July, 1917; the *American Historical Review*, July, 1917, was not unfriendly. "His endeavor to interpret history in terms of race is a legitimate and alluring enterprise, even if he goes rather far in claiming originality for the idea." "The book contains much solid scientific and historical truth." The *New York Sun*, April 7th, 1918, gave a very favorable review. "Get the book and read it; it's worth while." The *British Medical Journal*, August 18th, 1917, said: "While not prepared to go all the way with the author into the debatable region of practical engenics, we can commend his treatise to serious students."

In closing this too brief review, which is really more of an objective analysis of a book's reception, it is interesting to summarize the matter. Nearly all the reviews published in scientific journals or in the leading newspapers were either favorable or moderately favorable. The distinctly unfavorable were either important British reviews, which were apparently actuated by war-emotion, or were published in American newspapers and magazines and signed by persons of non-Nordic race.

Thinking upon all this has suggested to the present reviewer the following idea: Animosity against any pretentions of superiority on the part of members of one race over members of another merely on the ground of *race* is bound to bring about special and instantaneous resentment in nearly every instance. This is because a peculiar reaction takes place which is itself of evolutionary origin and of survival value, and has been a distinctly human trait ever since the species *Homo sapiens* began to differentiate from the other anthropoids. Men have evolved in group formation and men will resent an injury to the group, or fight for the group where they would not move a muscle on their own account. This principle is so strong that we often witness it as a sort of professional *ésprit de corps*. This makes it almost impossible to have a cold-blooded discussion of racial questions, or an objective classification of temperamental matters on which humanity in general will agree. It is too much a question of norms, too much a question of ultimate values.

This, however, does not prevent a good deal of reasonably accurate classification and tabulation of racial psychological differences. We may not be able to get agreement as to whether pure science or pure song be of the better worth, but it is possible to map geographically the origin of both science and song; and up to date a good deal has been done in the way of mapping racially the origin of science, both pure and applied, including administration faculties, success in business, war, and government. So far, the weights all fall tremendously to the credit of the Nordic race.

There can be no question that the Nordic race is and has been a superior one. Whether it is passing or not is a question. Perhaps future researches may make it possible to forecast these racial and historical problems.—

FREDERICK ADAMS WOODS.

A FLORAL ABNORMALITY OF THE INDIAN WATER LILY

Prolification and Phyllomorphy in Nymphaea Rubra

P. M. Debbarman
Howra, India

THE curious specimen described below appears to be worth placing on record as an example principally of axial floral prolification of the flower and phyllomorphy of the stamens.

In this specimen a small supernumerary flower with a distinct pedicel has issued from the axil of one of the inner petals of a normal-sized flower of *Nymphaea rubra Roxb.* The stamens have been transformed into small leaf-like structures thus exhibiting "phyllomorphy." This latter change is very striking in view of the fact that the structure of an anther is usually far removed from that of an ordinary leaf. The ovary has been found to be filled with a brownish-yellow mass and covered with intricate woolly hairs. No trace of any stamens or ovary has been found inside the supernumerary flower, which is quite small in comparison with normal flowers. Not only the flowers but even the leaves in this specimen are found to be rather modified in shape and size.

LEAVES FROM STAMENS

Figure 18. Several stamens have developed into small, leaf-like structures, and a supernumerary flower has grown from the axils of one of the petals. Leaves and stamens are structurally so different that such a change of characters is remarkable. It is not known what caused this variation, but it is believed to be due either to a parasite or to a nutritional disturbance.

Masters has recorded a somewhat similar specimen of Nymphaea in his *Vegetable Teratology*. The present one, however, primarily differs from the latter in the following respects—(1) the scape is free from any sign of torsion; (2) the supernumerary flower has apparently proceeded from the axil of a petal; (3) long matted hairs cover the disc and the abortive ovary and (4) the leaves are modified in size and shape.

It seems quite probable that two different kinds of factors—one internal and the other external—might have been at work here, giving rise to these structural deviations. On the one hand the presence of the supernumerary flower and the change in the shape and size of the leaves lead us to suspect that these might have been due to some internal cause (e. g. nutrition), and, on the other hand, the abnormal tissue in the abortive ovary and the hairs on it, lead us to suspect some external factor (e. g. a parasite).

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ALEXANDER GRAHAM BELL EXAMINING THE NIPPLES OF ONE OF HIS MULTI-NIPPLED SHEEP

It is remarkable what a place the sheep house had in Mr. Bell's life. In it were used his inventions for weighing and feeding and marking his multi-nippled flock. The news of the birth of the lambs in it was wired to him every spring, no matter where he was. His conviction that the forces of heredity were among the greatest of all forces was as firm as his conviction that the vibrations of the human voice could be transmitted electrically and that the aerial highway overhead would be traversed by man. It is significant that those eyes which could see so deeply into things should have made their last observations in this sheep house. Dr. Grenfell was several times a visitor at Beinn Bhreagh on his way to Labrador. He is here shown sitting on a box beside Dr. Bell. Photograph by Gilbert Grosvenor.

SAVING THE SIX-NIPPLED BREED

Alexander Graham Bell

Mr. Bell's Last Contribution to Science, with An Introduction by Mrs. Bell

UNDER this title Dr. Alexander Graham Bell in June of this year [1922] dictated for preservation in his note-books the last of his summaries of his breed of "Multi-nippled Sheep" which for the past few years he had been in the habit of making every spring.

Whether he had any feeling that each such summary might be his last report on his long-continued sheep experiments does not appear. He never said so. But he was one of those unhurried souls who are "Prepared to die today, but live as if sure of a hundred years for work."

Behind this title lies a whole romance as yet untold, full of dramatic incidents epitomic of Mr. Bell's own character.

As this sheep experiment was one of the last, so it was one of the first of the many investigations in which Mr. Bell engaged while living on Cape Breton Island, and a brief account of its beginning may possibly prove interesting.

In the year 1886 Mr. and Mrs. Bell brought their two little girls to Baddeck, having determined to make their summer home on the island.

They found a tiny deserted cottage, sufficiently far from the village, and near the water's edge to satisfy their requirements for the time. The cottage had no furniture except a dining-table, and little could be bought in the village, so the family themselves made most of what they needed, and slept on bags stuffed with hay.

To this primitive, but very happy home, Mr. Bell one day brought a little lamb. It soon became part of the family circle, following the children wherever they went, in and out of the house. When the time came to leave for the winter the children would not hear of giving away their pet, so arrangements were made for its care through the winter. The next summer when the family returned, *two* sheep, the mother sheep and her little lamb, greeted them.

But why only one lamb?

A progeny of nineteen was no uncommon event in a pig's family. Even dogs generally had as many as six at a birth, while twin lambs were rare, and quadruples unheard of. Yet there was valuable wool and meat to be obtained from sheep. Would not twins double the farmer's income without materially increasing his labor?

The argument that he preferred one good lamb to two poor ones did not seem conclusive to Mr. Bell, for the farmer most certainly had no objection to many pig babies, and neither the pig nor the dog mother had difficulty in rearing a large proportion of their children to fine maturity. Why could not the sheep do so too? The problem fascinated Mr. Bell. Here was what seemed to him an opportunity to satisfy his scientific curiosity, and at the same time serve the people among whom he had made his home.

Mr. Bell began the investigation of his problem by a careful physical examination of the sheep themselves, and soon discovered that while dogs have several *milk-bags,* and pigs, with much larger litters, have a great number of them; sheep as a rule only possessed one pair. Here, he considered, might lie the cause of the difference in the number of young produced. Of course the number of children a mother can profitably rear must bear some proportion to the amount of milk she had for them, and this also was dependent on the number of milk-bags, or nipples she possessed. The problem therefore at the very outset narrowed down to the possibility of multiplying the number of nipples found on a sheep.

Mr. Bell noticed traces of rudimentary nipples on some of the sheep examined, and gathered confidence that by a careful scientific process of selection, these rudimentary nipples could be developed into functional milk-bags, secreting sufficient milk for the proper rearing of a number of lambs at a birth.

In such manner began the experiments to create a many-nippled breed of sheep, ultimately to be developed into a true twin-bearing variety. These were continued with varying degrees of success, but never-failing interest on Mr. Bell's part, to the end of his life. A great amount of time, study and personal labor was bestowed upon them every year. Whenever possible he was at hand to welcome the lambs in early spring, and to superintend the mating in the autumn. On one occasion he even crossed the Atlantic largely for that purpose, returning to Europe afterwards.

During the first years Mr. Bell paid especial attention to the details of the care of his sheep throughout the long Northern winters. Believing that high, dry pasturage was particularly beneficial, and that the division of animals into small groups made their protection against epidemics more easy, he built a veritable village of small sheep houses on the top of Beinn Bhreagh. He named this "Sheepville" and it had regular main and cross streets, which also had their individual names. Nearly every day for some years he conducted his sometimes rather reluctant family up the mountain, often through deep snow, to visit those sheep, and they became personally acquainted with Generals Grant and Lee, the first sires of the breed.

It was not practicable, however, to remain every winter at Beinn Bhreagh, and gradually the personal care of the sheep was left to shepherds, who unfortunately did not always deserve the confidence reposed in them. On one occasion the whole flock was almost wiped out of existence by the indifference of a shepherd, who left it outside the houses one night during a wild March blizzard; on another only three sheep escaped the ravages of wild dogs. Even when Mr. Bell went to the expense of importing a medical student from Washington to supply his own place during an enforced absence, he can hardly be said to have been more lucky, since the scientific interest of this gentleman was so keen that he cut open one of the crack ewes to see if it really had twins! It is perhaps permissible therefore to question whether, with more intelligent understanding and greater care on the part of his assistants, Mr. Bell might not have advanced further in the establishment of his variety of six-nippled, twin-bearing sheep.

However this may be, Mr. Bell himself never failed in the devotion with which he conducted his own share of the work. The scope of the investigation indeed narrowed. When Davidson left his employ some years ago he discontinued the minute weighing of each sheep before and after meals, and during rain and sunshine, and the individual feeding of measured quantities of food and observations on the influence of greater or less food, or different kinds of food on ewes during, and after, or before pregnancy, which some one protested was likely to weigh the animals out of existence! But there never was any diminution in the amount of care exercised in the selection of sheep for continued breeding. The languor of illness was already on him when he made the examination of the sheep on which this last summary was based, but there was not the smallest deviation from the usual routine. The sheep were gathered into one of the barns, the mother ewe and her lambs identified; the ewe's number looked up in the catalogue, holding it there while Mr. Bell and the farmer critically examined each nipple. Where the animal examined was a ewe the nipples were tested to ascertain whether they had functioned.

FEEDING THE SHEEP

FIGURE 1. Dr. Bell always kept a box of oats by the gate of the sheep pasture, which was very close to his house. Very often when he came back from his office in the late afternoon he would take some of his grandchildren down to feed the sheep. He was delighted in having his flock tame enough so that they would eat from his hand.

In the case of the lambs, both male and female, the size and position of the nipples with reference to each other was carefully noted and measured. Often for further elucidation profile drawings were made in the note-book. Then the size and general bodily condition of both sheep and lambs were considered, and decision rendered whether or not all requirements had been successfully met. If the verdict was unfavorable the ears of the lamb were simply clipped to prevent future confusion, and it was discarded from "Mrs. Bell's Twin-Bearing Flock." Holes were punched in the ears of the accepted sheep after a method of Mr. Bell's own devising, which through their position designated the number assigned to that particular lamb in the sheep catalogue. This number was given only to that sheep and will always identify it beyond doubt. When the owner of it, whether from failure to meet later requirements or from other causes, no longer belongs to the flock, that number still remains in the catalogue, mute evidence of such a sheep having once existed.

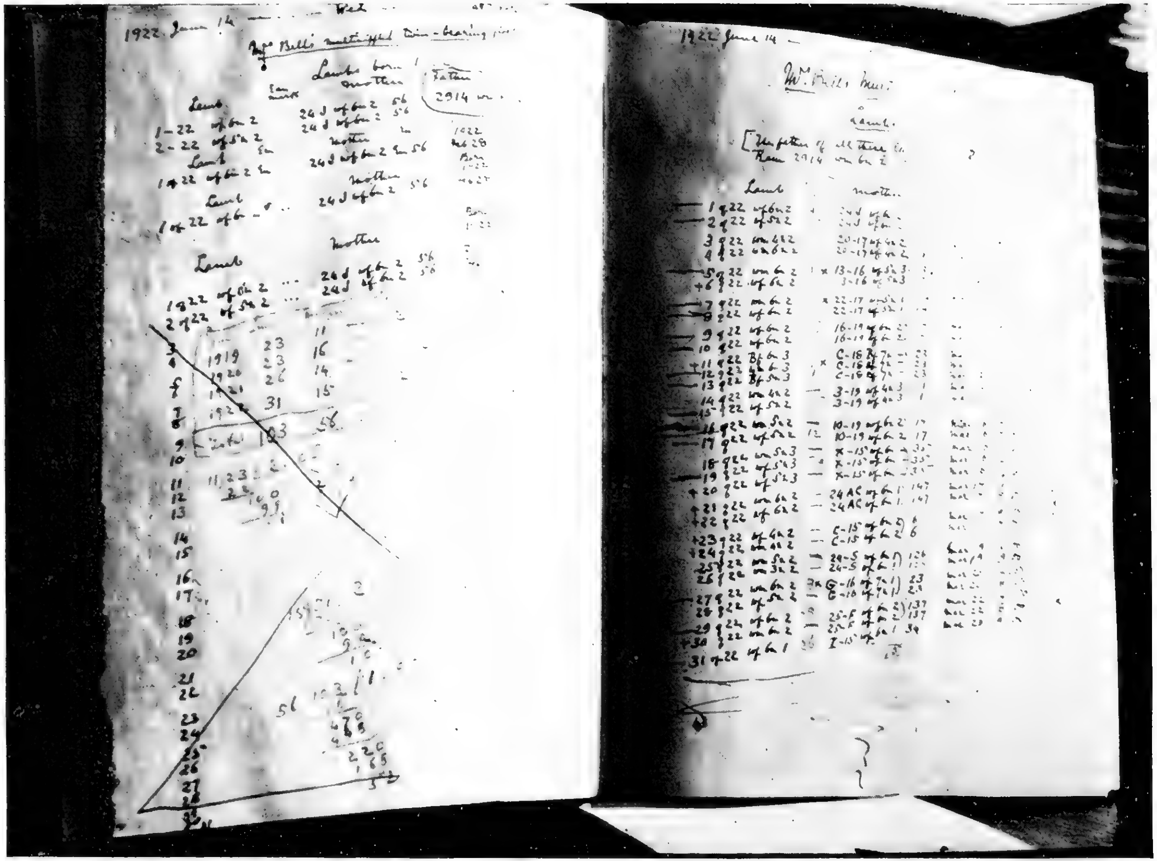
In all, Mr. Bell this year examined in this minute way fifty-one sheep. It involved two mornings of hard work on the part of all four men engaged, and Mr. Bell followed this by four nights of labor, going over the results and tabulating them. This meant filling ten large sheets of his note-book with several columns of figures and notes written in his own small handwriting. All this was gone through before the summary could be started.

Mr. Bell, of course, must have been very tired at the finish, but he was too much interested and pleased with the condition in which he found his flock, to be even aware of fatigue.

The Summary is presented exactly as Mr. Bell left it, and it is perhaps interesting to note that the language is exactly as it came from his lips, without change or correction. He looked the original dictation over, and directed that it be typewritten as it stood.

He would, of course, have made changes in its wording, had he himself prepared it for publication, for he was very critical of every word used and in the construction of every sentence. The formation of the last two sentences Nos. 3 and 4 in the paragraph describing the result of the process of selection in "Mrs. Bell's Flock," for example, will not scan, but is left untouched.

Mabel Gardiner Bell.



ALEXANDER GRAHAM BELL'S LAST CONTRIBUTION TO SCIENCE

FIGURE 2. Mr. Bell's last work shortly before his death was to note down in his book of "Home Notes" the size, number, and distribution of the nipples of the twin lambs born in the spring of 1922. This he did with that same painstaking accuracy with which through all his life he recorded his observations. The above is a photograph of a page in his notebook as his pen left it. The abbreviations, and the system of numbers, he developed to make the record work easier. Nothing was ever allowed to go unverified and it is interesting to see how he checked up the very simple problem on the left-hand page by "Casting out nines," which method he learned from the census tabulators with whom he was associated when he had charge of the special census for the deaf and blind in 1900. Photograph by David Fairchild.

"MRS. BELL'S LITTLE FLOCK"

FIGURE 3. Mrs. Bell's little flock of multi-nippled twin-bearing sheep photographed in August, 1922. This flock was made up of selected ewes having four or more functional nipples, and whose first lambs were twins. Photograph by David Fairchild.

IN[1] 1914 I had made up my mind to give up the sheep-breeding experiments which I had been carrying on since 1890, by handing the sheep over to a younger man, Mr. J. G. Davidson, of Stewiacke, N. S. Mr. Davidson had had charge of the sheep on Beinn Bhreagh for some years previously and was thoroughly familiar with the experimental plans adopted. I made an arrangement with him to carry on the experiments in Stewiacke, N. S., for at least a period of five years as a commercial enterprise of his own.

By 1914 we had developed a six-nippled breed of sheep, but considerable difficulty had been experienced in getting the flock to breed truly to the point of selection adopted. This was shown by the fact that the best nippled sheep on the place were the offspring of sheep that had been purchased from farmers who had used our rams, and very few of them were of our own breeding on both father's and mother's side.

In 1914 the best nippled sheep were formed into a flock and removed to Stewiacke, N. S., in charge of Mr. Davidson, and we had an auction sale of all of the other sheep on the place to farmers who lived around here. After having kept careful sheep breeding records for twenty-four years, I felt rather lost at first to find myself without any sheep of my own breeding and then discovered that Mrs. Bell also felt very badly over the fact that I had deprived myself of all my sheep breeding material. In fact she felt so badly over the matter that she made private arrangements with Mr. John MacDermid to buy in a few of the sheep for herself, in the hope that I would take them up again. To my surprise therefore, I found after all that we were still in possession of a small flock of sheep, consisting chiefly of sheep that no one else wanted to buy! Among these sheep was a young ram No. 2308, a black male six-nippled twin. Its father was also a six-nippled twin, and the mother, too, so that he was presumed to have a hereditary tendency

[1] Copied without alteration from Mr. Bell's notes.

A MULTI-NIPPLED TWIN-BEARING EWE

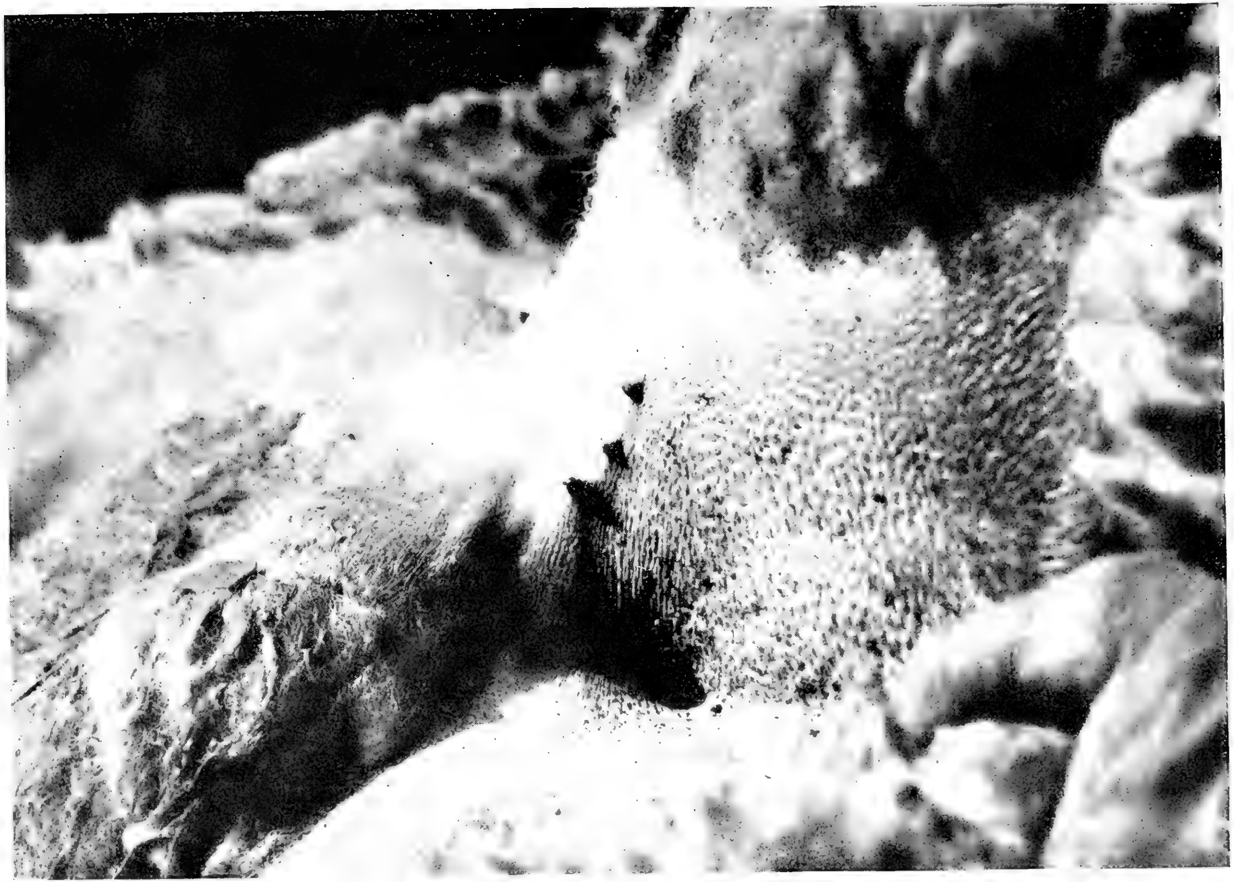
FIGURE 4. This ewe is earmarked 13 of the Beinn Bhreagh flock. She has six functional nipples, as shown in Figure 5. The first problem in developing a twin-bearing race of sheep was to multiply the natural milk supply so that more than one lamb could be adequately nourished. Thus the difficulties of producing a twin-bearing strain are greatly increased at the start. Photograph by David Fairchild.

SIX FUNCTIONAL NIPPLES

FIGURE 5. These are the nipples of the ewe shown in Figure 4. Not only does she have four extra nipples, but she bears twins as well. By selecting ewes with this desirable combination of characters, and mating them with rams from a twin-bearing multi-nippled strain, Dr. Bell hoped to develop a breed that would multiply with greater rapidity than do the recognized breeds of sheep today. Photograph by David Fairchild.

A SIRE OF THE MULTI-NIPPLED BREED

FIGURE 6. This ram, earmarked 13 of the Beinn Bhreagh flock, has six non-functional nipples, as shown in Figure 7. By mating such a ram with twin-bearing multi-nippled ewes, many more lambs would be expected to be multi-nippled than would be from a sire that had only the normal number of non-fractional nipples. Photograph by David Fairchild.

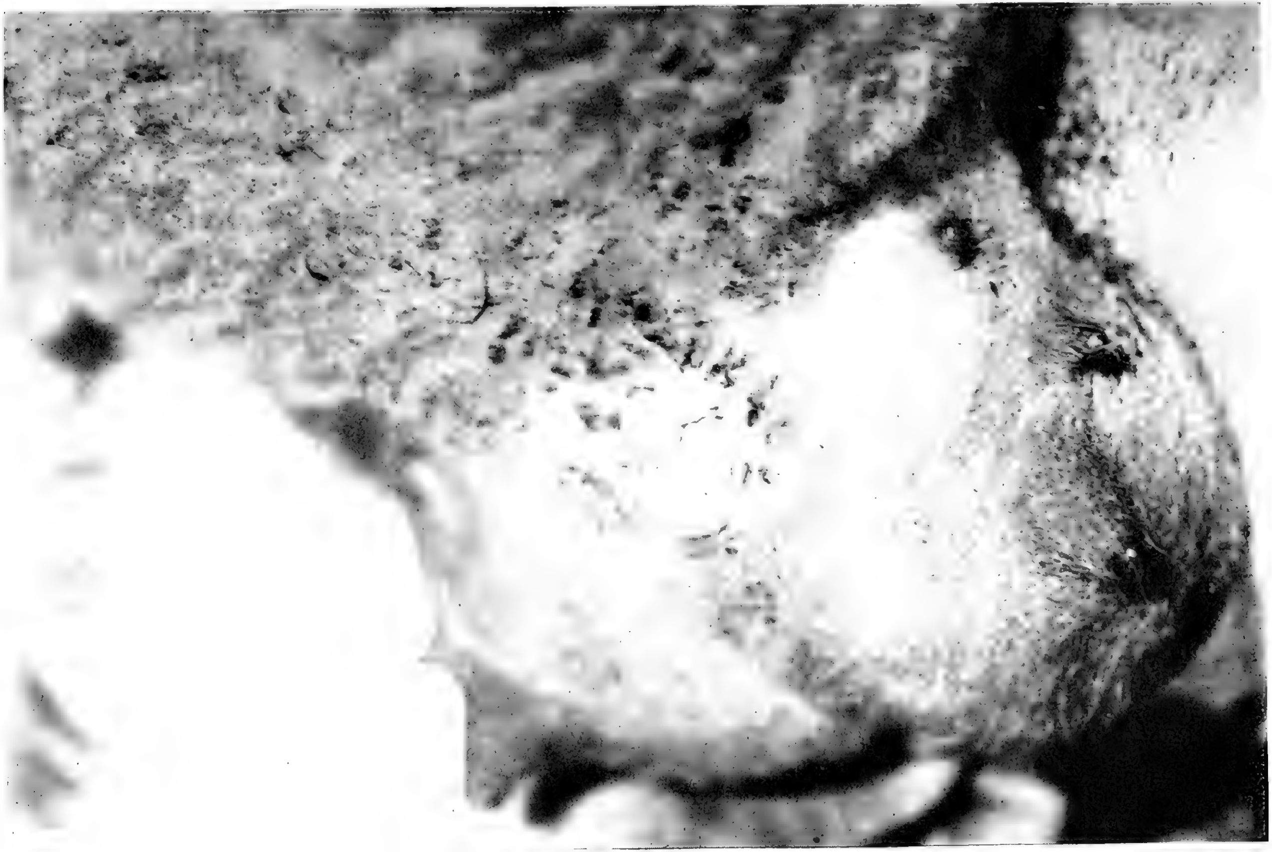


UNDEVELOPED NIPPLES ON RAM THIRTEEN

FIGURE 7. Showing the small non-functional nipples of the ram shown in Figure 6. Three nipples are clearly visible, and the tips of two of the others can just be seen. Photograph by David Fairchild.

FOUR FUNCTIONAL NIPPLES

Figure 8. Dr. Bell found that it was not very difficult to get ewes with supernumerary nipples, but that it was necessary that these extra nipples should be functional. This ewe was purchased from a farmer in the neighborhood of Beinn Bhreagh. It is probable that she has the blood of one of Dr. Bell's multi-nippled rams in her veins, as they were loaned to the farmers in the region. Photograph by David Fairchild.



UDDER OF EWE EARMARKED SEVEN

FIGURE 9. Five of the six functional nipples are shown. One pair is larger than the other four, but all of the nipples produced milk. Dogs and pigs have a larger number of nipples than this, and rear proportionally larger families. There is evidently a definite relation between the number of young born and the amount of milk available to feed them. Photograph by David Fairchild.

toward the production of six-nippled and twin offspring. However, nobody wanted a black ram, and John MacDermid bought him in for a song, for Mrs. Bell's flock.

Mrs. Bell was more interested in the production of a twin-bearing stock than in one six-nippled. This was the origin of the twin-bearing flock, and after the sale I found that instead of having no flock to look after I was called upon to care for two, a six-nippled one at Stewiacke, and a twin-bearing one at Beinn Bhreagh.

The principles of breeding were different for the two flocks. Mrs. Bell wanted twins and was satisfied that the ewes should have only four nipples, so long as the second pair of nipples were of the same size as the primary pair and were functioning—yielding milk. The principal point of selection in her flock was to keep lambs having the second pair of nipples as large as the first. They might have five or six or even more, but she considered these unimportant, provided that they had at least four well-developed, well-separated nipples yielding milk.

An examination of her flock revealed the fact that we had in the past been too anxious about the mere number of nipples instead of their size and general development. In nearly every case the supernumerary mammae were small and not functional in adult life.

This doubtless had been the reason for our failure to establish the six-nippled tendency as a hereditary trait, so that the best nippled lambs were exceptional creatures found in the flocks of farmers who had used our rams. The lambs purchased from farmers were designated by letters of the alphabet so that it was easy to distinguish the ewes that had been purchased from those of our own breeding.

In process of time we got rid of the lambs with small extra nipples, keeping only those with nipples moderately developed, and it really was curious to note how many of the sheep ultimately retained had mothers with the letters of the alphabet in their names. (Footnote by Mrs. Bell: It should be noted, however, that in nearly every case these purchased sheep have been found to be descendants of Mr. Bell's rams and it is possible to trace each one to its particular ancestor—whose number is preserved in the catalogue.)

Finding that very few of our lambs had extra nipples of the desired size, and realizing that it would take a long time to develop a small flock, we sent out an exploring expedition to examine sheep of the surrounding farmers and see whether we could not pick up a few adult ewes with extra nipples as large and well developed as the primary suckling pair. Mr. MacIver was very successful in this and succeeded in purchasing no less than sixteen ewes in which the secondary pair of nipples were of enormous size. They not only yielded milk but had evidently been sucked by their lambs. These ewes were added to the farmer's flock as we could not very well give them identifying names as their ears were already mutilated by the farmer's clippers. We have obtained from these ewes quite a number of lambs with secondary nipples apparently as large as the primary pair; and these have been added to Mrs. Bell's flock.

After the sale of sheep in 1914 I found myself special adviser in chief to two distinct flocks, 1. Davidson's six-nippled flock at Stewiacke. 2. Mrs. Bell's Twin-bearing flock at Beinn Bhreagh and to these we speedily had to add a third—the farmer's flock at Beinn Bhreagh, consisting of sheep which had been rejected from Mrs. Bell's flock and remained in Mr. MacIver's care for sale or other disposal.

The ewes of the farmer's flock that were wintered were mated with thorough-bred Shropshire Society rams with the object of improving the fleece and the hope that some of the lambs with improved fleece would turn out to have the characteristics desired for Mrs. Bell's flock, and thus enable us

to introduce the improved fleece into Mrs. Bell's Twin-bearing flock.

The principles of selection adopted in Mrs. Bell's Twin-bearing flock were as follows:

1. The nipples of the lambs were examined. The lambs having four or more well-developed, well-separated nipples of about equal size were retained in the flock and those that did not come up to this requirement were transferred to the farmer's flock.
2. In the autumn the lambs remaining in Mrs. Bell's flock were weighed, and the average weight ascertained. The lambs weighing more than the average were retained and the others transferred to the farmer's flock.
3. Innumerable experiments in the past having demonstrated that when mating was accomplished in October the proportion of twin lambs was very much greater than when mating occurred in November, and that very few twins resulted from December mating, the October mating season was retained.
4. When the lambs became two years old some of them were found to have twins of their own, while others had only single lambs. The ewes that had twins when two years old were retained in Mrs. Bell's flock and the others transferred to the farmer's flock.

As a result of these processes of selection the adult ewes of Mrs. Bell's flock consist of:

1. Sheep having four or more well-developed, well-separated nipples yielding milk.
2. Ewes weighing more than the average weight of ewes of their age.
3. They were all of them ewes that had had twins when two years of age.
4. They were all mated in October and had their lambs in March.

It was found that with very few exceptions these ewes continued to bear twins or triplets every year with hardly any single lambs. The few failures were transferred to the farmer's flock, and we now find that the adult ewes of Mrs. Bell's flock constitute a true twin-bearing stock. They always give us twins or triplets with hardly a single lamb, and the twins and triplets born are found to be in the autumn fully the equals in weight of single lambs, showing that the mother yielded milk enough for the support of more than one lamb.

We are uncertain as yet whether the twin-bearing tendency is a hereditary characteristic, for the ewes transferred to the farmer's flock were mated in December and very few of them have twins born in May. The flock, however, has been too small to enable us to carry out experiments to determine this point with certainty. All that we can say is that Mrs. Bell's flock can be relied upon to give us twins and triplets every year with only an occasional reversion to single lambs.

For example, thirty-one lambs were born this year: of these only one was a single lamb; twenty-four were twins (twelve pairs); six were triplets (two sets).

Special Notice

Since the death of Mrs. Bell, Jan. 3, 1923, her daughters have felt the desirability of placing the multi-nippled breed of sheep in the hands of breeders who would be interested in continuing Mrs. Bell's experiments or in preserving the two hereditary characters of multi-nipples and twin-bearing for future use in the improvement of established breeds, to which these characters could be be added to advantage.

I shall be glad to get into communication with institutions or with breeders of established reputation who are in a position to utilize in a thoroughly scientific way Mr. Bell's multi-nippled breed of sheep.

—[Editor.]

HEREDITY AND TUBERCULOSIS

A Review

A GENERATION ago, it was almost universally supposed that tuberculosis was due to heredity. Then medical opinion was led astray, and for some years the genetic factors in the case were depreciated. During the last decade a number of careful studies have corrected this mistake, until it is now clear that the inheritance of lack of resistance is one of the principal causes of death from consumption.

While in the United States last year, Albert Govaerts, director of the Office Belge d'Eugenique, made a study of this subject at the Eugenics Record Office, and his results have been published as *Bulletin No.* 23 of that office.[1] He reviews in a sketchy and inadequate way some of the other studies of the subject, notes the important work of Sewall Wright and P. R. Lewis on guinea pigs, and then publishes his own contribution, which is an analysis of family histories taken from the archives of the Eugenics Record Office.

The analogy of the breeding experiments agrees very nicely with the conclusions that had previously been drawn as to the inheritance of resistance to tuberculosis in man. Tests made on more than 100 guinea pigs belonging to five closely inbred families show marked differences in susceptibility among the different families, and the rank of the various families in respect of resistance to tuberculosis bears no relation to their rank in respect of the various factors of general vigor. It is thus clear that independent hereditary factors are involved; moreover, in particular crosses the average of the progeny is consistently superior to either parental line, indicating that the latter are susceptible for different reasons, each being able to supply what the other lacks. In general, resistance is dominant over susceptibility, and there is equal transmission by sire and dam, and to sons and daughters.

When the various races of mankind are considered, a similar state of affairs is found. Negroes are notoriously susceptible to consumption; so are the American Indians, and in general, all the aboriginal peoples of the western hemisphere, who have been exposed to the disease only since 1492, and therefore have had not an opportunity to develop, through natural selection, a degree of immunity or resistance which is found among some of the peoples of the Old Word, where the bacillus has been at work for thousands of years, in all probability. And among the races of the Old World, the differences are striking enough: Louis Dublin has pointed out that in the state of New York the death rate from tuberculosis among the Irish is some four times as high as that of the Russians or Italians, males being considered in each case.

The problem was long ago attacked statistically by Karl Pearson and associates, who showed in a number of fundamental papers that there is about as much resemblance between parent and offspring, in prevalence of tuberculosis, as there is in respect of any of the commonly accepted inherited traits such as eye color or stature. On the other hand, the resemblance between husband and wife, in regard to tuberculosis, was not great, despite their prolonged and intimate association. All the evidence indicated that heredity, rather than mere contact with an infected person, is the most important factor in determining the incidence of

[1] Carnegie Institute of Washington, Eugenics Record Office, *Bulletin No.* 23. The Hereditary Factor in the Etiology of Tuberculosis, by Albert Govaerts, M. D. Reprinted from the American Review of Tuberculosis, September, 1922, vol. vi, pp. 547-565.

the disease. Raymond Pearl adds that "a tuberculous person, chosen at random in the working population of Baltimore, will have nearly six times as many blood relatives tuberculous as will a non-tuberculous person."

Supplementing these lines of investigation, whose extent and usefulness has here hardly been hinted at, Dr. Govaerts has made a more detailed analysis of 214 families, representing 5,629 individuals, in which occurred 185 tuberculous matings and 29 non-tuberculous matings. He calls "a tuberculous mating one in which the father or mother, one or both, are tuberculous or whose fraternity and ancestry are tuberculous. Non-tuberculous matings are matings in which no member of the family is tuberculous or belongs to a tuberculous stock."

The individuals are classified in two groups, "namely, close contact and non-close contact with tuberculosis of the lungs. Close contact means a close contact with a case of tuberculosis of the lungs during the whole or a part of life; non-close contact implies the opposite." If infection is more important than blood relationship, then most of the tuberculous individuals ought to be discovered to have had close contact, more or less prolonged, with some diseased person.

The opposite is the fact. The larger number of the tuberculous persons have not been in close contact with a "case."

On the other hand, when the material is classified according to the amount of tuberculosis in the ancestry, the frequency of the disease among the children is found to vary directly with its frequency among their forebears.

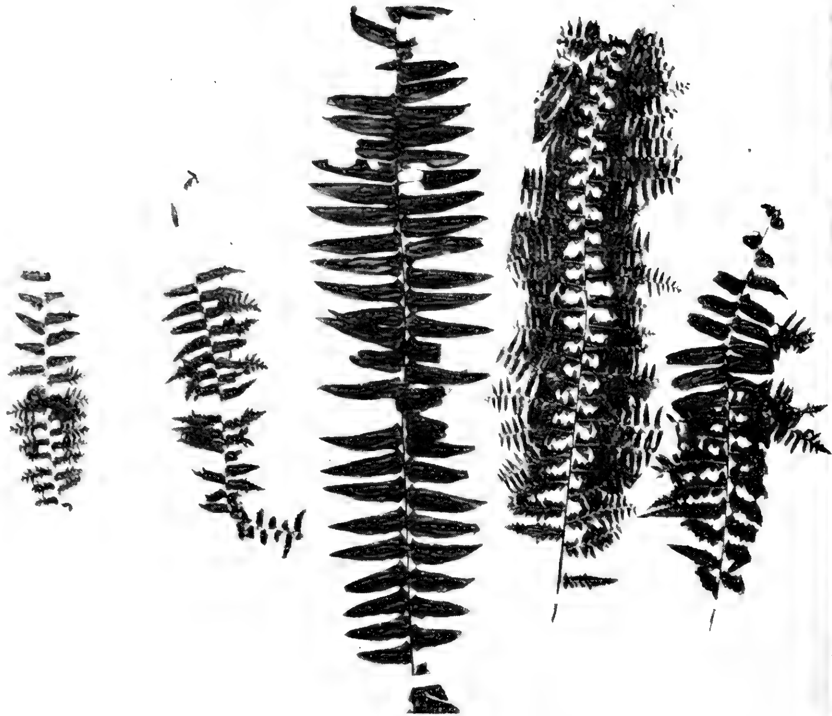
The unexpected result is developed that the influence of the father, in transmitting weakened resistance to the disease, is greater than that of the mother. "Wherever the paternal stock alone is known to be tainted, more of the children show active tuberculosis than when the maternal alone is known to be tainted." As the children are much more closely associated in daily life with the mother than with the father, and most of them have been nourished by her milk in the first year of life, this fact—if substantiated—tends still further to show the relatively small importance of the mere matter of contact or exposure.

Dr. Govaerts discusses somewhat vaguely the question whether the results of his studies indicate a simple Mendelian form of inheritance. He reaches no conclusion, and his material hardly lends itself to analysis on this point.

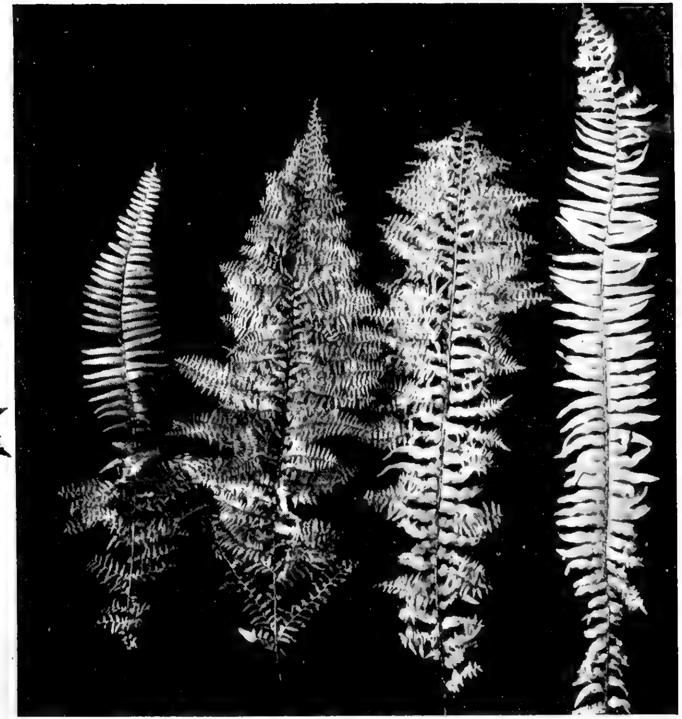
Outlining his own interpretation of the results of his study, Dr. Govaerts says:

> One cannot maintain that there can be tuberculosis without infection, but various considerations may still be urged to support the view that different persons have the power to resist the infection in different degrees, and that in consumptive families a lack of resisting power is transmitted from gametes to children. The tubercle bacillus is everywhere about us. Some people entirely escape its attack, while in others the disease may occur in such a slight form that the person attacked recovers from it without being aware that anything has been wrong.
>
> Tuberculosis is not an inheritable character in the sense in which eye color is inheritable. It belongs to a second kind of heredity called *indirect heredity*. Infection and immunity are causes, but they do not exclude inheritance. Biologically speaking, people inherit directly a constitutional make-up, possibly functional, chemical, and structural, with a certain amount of power to resist tuberculosis or other related diseases.
>
> From the social and eugenical point of view it is very important that tuberculosis is transmitted approximately in a Mendelian sense. So it seems possible to establish some principles based on the law of averages.
>
> From present knowledge no one is able to give advice to normal persons or one apparently normal for a contemplated marriage. Advice is possible only in extreme cases and we need still more minute investigations and studies. Nevertheless, it will be useful to dissuade marriage between two stocks in which the same defect is apparent. In such stocks consanguineous marriages are dangerous. A tuberculous subject will find more advantage for his progeny by marrying a person belonging to a resistant strain. Eugenical marriages should be between normals and those free from defects.

PAUL POPENOE.



Wild Whitmani



Cultivated Whitmani

WILD AND CULTIVATED STRAINS OF THE "WHITMANI" FERN

FIGURE 10. At the left are the leaves sent in by Mr. Simpson from plants which have grown wild for twelve years at Little River, Florida. They correspond in general character of division to leaves produced by a reverting strain of that variety grown under greenhouse conditions, except that they are smaller than normal. The once-pinnate leaf at the left is probably a temporary vegetative reversion of the divided type. At the right are the leaves of a reverting strain of *Whitmani* grown at the Brooklyn Botanic Garden. These leaves average larger than those sent by Mr. Simpson, and the amount of division is greater, nearly thrice-pinnate, but this would be expected under the better conditions of greenhouse culture. It is an interesting point that this particular strain, which has been under culture at Brooklyn for eight years still maintains the characteristics represented in the picture taken in 1916. From it may be raised runner progeny of practically typical *Whitmani* characteristics, but it has not been possible to separate a strain in which the once-pinnate condition is entirely fixed.

ARTIFICIAL VARIETIES UNDER NATURAL CONDITIONS

Can the Bud Sports of the Boston Fern Thrive Under Conditions of Natural Selection?

R. C. Benedict

Brooklyn Botanic Garden.

IN AN article published as a leaflet of the Brooklyn Botanic Garden (Series X No. 3, 1922), the suggestion was made that it would be a matter of considerable interest to determine experimentally whether any of the horticultural forms of the Boston fern, produced by the artificial selection of florists, would be able to stand the test of natural conditions; in other words, whether they are fit to survive on the basis of natural selection. It was further suggested that such a test might easily be made by setting out, say in Florida, under favorable wild conditions, a selection of the stronger cultivated types. Following the distribution of the leaflet a letter was received from Mr. Charles T. Simpson of Little River, Florida, which bears directly on the problem:

> Your letter of July 1 and the accompanying fern papers reached me in due time but I am a very busy old man and my eyes trouble me so I can read but little. Today I have just glanced over the papers which are very interesting.
>
> I have lived on this place, which has a couple of acres of hammock, for twenty years. When I came here *Nephrolepis exaltata* grew sparingly in a part of my hammock and on the two cabbage palmettos.
>
> Perhaps twelve years ago, I cannot remember, I turned out of my slat house a plant of the form you call *Whitmani* into a part of the hammock which had no *exaltata*, but not more than six or seven rods from a patch of it. I think I put out only a single plant,—certainly very few—but now the *Whitmani* covers irregularly over two square rods of the floor of the forest. It is a rather open hammock and not so favorable for ferns as if it were thick and damp.
>
> At least seventy-five per cent of these ferns hold to the *Whitmani* type fairly well. Now and then there is a pure (?) *exaltata* and there are some intermediates. I am enclosing a few specimens. It is possible that spores from the *exaltata* may have been borne by wind or other means and lodged among the *Whitmani;* that they may have grown and made some of the plain plants.
>
> A few of the *Whitmani* plants are growing naturally a short distance above ground on trunks of trees, not more than a foot or so.

The accompanying illustration shows the leaves sent in by Mr. Simpson. As will be seen, they manifest variable and irregular division from plain once-pinnate to twice-pinnate. Typical *Whitmani* develops thick, plumy, thrice-pinnate leaves under the best greenhouse conditions, but when grown in untoward circumstances, and especially in reverting strains, it will produce leaves of the type shown. It is not to be expected that the dense leaves of the favorable florists' environment, —rich soil, absence of competition, moist air,—would be reproduced under open conditions of a drafty hammock.

It does not follow that the plants showing only once-pinnate leaves are necessarily, as suggested by Mr. Simpson, true wild *exaltata.* The leaves sent in appeared much too thin for the wild type. In a reverting strain, *Whitmani* will normally produce occasional crowns with practically complete reversion. I could duplicate the series of leaves shown by a selection of leaves from one pot of reverting *Whitmani* in the Brooklyn Botanic Garden cultures. The plain once-divided leaves of such a plant of reverting *Whitmani*

are always thinner than leaves of wild *exaltata* grown under identical conditions and differ further in that they produce no fertile sporangia.

Two points are of special interest in connection with these plants reported by Mr. Simpson:

First, that a rather delicate, greenhouse variety of Boston fern, *Whitmani*, has maintained itself and increased over a period of twelve years under conditions of natural competition.

Second, that the plants have retained an approximation of the typical form of the leaf. Given best greenhouse conditions, it is almost certain that these naturalized plants would show the typical plume type of the normal *Whitmani*.

If any reader is in a position to make a more extended test of other varieties, I shall be glad to send a selection, including some new, unnamed types, which would answer all the requirements of specific distinction, according to descriptive taxonomy.

FURTHER POINTS ON THE RELATION OF CYTOLOGY AND GENETICS*

P. W. WHITING
Iowa Child Welfare Research Station.

IN VIEW of the recent announcement of G. H. Shull[6]† that he has actually found crossing over in Oenothera, the remarks of R. Ruggles Gates[2] in reference to the cytological conditions should be considered. Gates (p. 76) states, "As is well known, in Oenothera the chromosomes form a chain end-to-end like a string of sausages, and when they ultimately come to be side-by-side in diakinesis they are already in the short and stout condition in which twisting about each other is impossible. This is a very disturbing fact for those who write about 'crossing over' in Oenothera." Just why geneticists should be disturbed by an end-to-end arrangement of sausage-like chromosomes I am unable to understand. It is obviously up to those who insist on some other explanation of crossing over than that usually held, to show that these sausage-shaped chromosomes are of the same constitution as those that entered into synapsis. The fact that the diploid number should occur in late prophase preceding the first maturation or heterotypic division throws no light upon the stages when crossing over occurs.

Crossing Over in Fine Thread Stage

Plough[4] (p. 187) from temperature experiments with Drosophila, has shown that crossing over occurs at a very early stage when the chromatin threads are extremely tenuous, "in what resembled a late leptotene or early diplotene condition in other forms." Such stages have not as yet been adequately studied in Oenothera. Refering to this genus in an earlier paper[3] (p. 11) Gates writes, "in the earlier stages . . . parallel threads could not be observed, and it has not been determined whether they were really absent or whether the failure to observe them was due to their extreme delicacy." Wenrich's[8] careful studies on leptotene and zygotene stages in spermatocytes of the grasshopper, Phrynotettix, which is evidently very favorable material, have

* A reply to "Some Points on the Relation of Cytology and Genetics," by R. R. Gates, in *The Journal of Heredity* for February, 1922.

† For Numbered References, see *Literature Cited,* at end of article.

clearly shown parasynapsis of very fine threads, but in view of the difficulty of fixation in much botanical material it is not surprising that this phenonemon has not been more widely observed.

Structure of First Maturation Chromosomes

The number of elements, chromatids, present in the chromosomes of the heterotypic division seems to be a bone of contention among cytologists. Zoologists have for the most part, at least recently, held that there are four, and have hence designated these chromosomes as tetrads. Botanists, as in the case of Gates, perhaps because their material is not so easily fixed, have usually been unable to see more than two elements at this stage, and have consequently preferred the term, bivalent chromosomes. Recently, however, Taylor[7] in a preliminary report on the organization of heterotypic chromosomes of the Liliaceous genus Gasteria, states that clefts appear in the ends of the metaphase chromosomes, separating monads, and that the latter are completely separated at anaphase. The conclusion is therefore unavoidable that in this plant material at least the first maturation chromosomes are tetrads in structure. The term bivalent may well be retained, nevertheless, to denote origin.

Failure to reveal the tetrad nature in many cases is evidence merely that the chromatids tend to associate much more closely in pairs than the pairs associate with each other. To use a chemical analogy, we might say that the valence of each chromatid is more or less satisfied by very close union with one other chromatid. Homologous or sister pairs may then be more loosely associated giving the appearance of double elements which are really quadruple.

Structure of Spirene Chromosomes

A comparable situation is to be observed in spireme stages, preceding maturation. It is often stated that the homologous chromosomes twist about each other in long threads. This is only partly true as I have pointed out in the spermatogenesis of Culex.[9] Two twisted chromatin threads indeed appear, but each of these threads consists in any loop of two tightly fused elements, chromatids. While the threads in one loop may represent portions of homologous chromosomes, the threads of the next loop may represent fused daughters of homologues. In other words the chromatids have changed partners at the apparent point of junction. The spireme chromosome then is really a tetrad, for it is made up of four elements.

Spireme Structure and Crossing Over

The fundamental quadruple nature of the early spireme thread is of importance in relation to genetics. Bridges[1] (p. 134) from a study of equational non-disjunction has shown that non-disjunction of the equational and of the ordinary reductional type may occur at the same time in the same "pair" of chromosomes. This necessitates crossing over in the four-strand stage. "It is impossible that a non-cross over and a cross over chromosome come from a cell in which only two strands are present. Therefore the proof that these exceptions arise from XX (or XXY) oocytes would at the same time prove that crossing over took place in this manner at a four strand stage." But since Plough's results show crossing over to occur very early, we will perhaps have to conclude that even the zygotene threads, although apparently double, are really quadruple, the double appearance being due to the same principle of "satisfied valence" which causes the later spireme also to appear double and the diakinesis tetrads in some cases to appear as "dyads."

Robertson[5] has reported precocious splitting of anaphase chromosomes in the last spermatogonial division, a cytological fact which may be taken as evidence of double nature of lep-

totene threads and hence of quadruple nature of zygotene threads.

If "change of partners" occurs between the four zygotene elements in various parts of their length, the extreme tenuity of the threads may here permit permanent breaks and refusions at the points of exchange, giving a basis for crossing over which is lacking in later stages, although "change of partners" takes place there also. Relative differences in condensation of threads at time of synapsis may therefore explain occurrence of crossing over in one sex and its failure in another.

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Discovery Made Simultaneously By Independent Investigators

In the two following articles on defective endosperm in maize it seems probable that the authors have independently discovered the same character, seeds that germinate on the cob. Further experiments would be necessary to prove definitely the similarity of the two defects. It is interesting if they have found the same character in two distinct varieties of sweet corn, and it is even more remarkable that the mailing of the manuscripts describing this discovery was so timed that they both reached us on the same day.

Not being gifted with Soloman's wisdom, we have avoided the rather complicated questions of priority involved by awarding the baby simultaneously to both mothers, as it were, and have printed the two articles in the same issue. Since Dr. Manglesdorf's manuscript arrived a few hours before Dr. Lindstrom's, we are giving the former priority of place.—*Editor.*

THE INHERITANCE OF DEFECTIVE SEEDS IN MAIZE[1]

P. C. Mangelsdorf

Connecticut Agricultural Experiment Station, New Haven.

DEFECTIVE seeds are heritable variations in maize in which the endosperm is lacking or is incomplete or abnormal in its development. These characters were first reported in the *Journal of Heredity* by Jones,[2] who observed them in several varieties of corn that had been self-fertilized for the first time. Crosses made by him, and later generations classified by the writer have shown that there is more than one type of this abnormality, and the first four defectives studied have been found to be genetically distinct.

In the past few years many experiment stations have begun projects for the improvement of corn by selection in self-fertilized lines. Altogether, more than six thousand strains of corn have been inbred for this purpose. This inbreeding has brought to light many recessive variations, previously covered up by the remarkable heterozygosity which exists in the average variety, and among these recessive variations there have been a large number of defective seed types. Defective seeds have appeared in all the so-called sub-species of maize with the possible exception of *tunicata* and in more than thirty representative American varieties as well as in several varieties from Spain and one from Peru. During the summer of 1922 crosses were made between many of these defectives and the four types originally tested at the Connecticut station in order to determine, if possible, the number of distinct genetic factors involved. Between fifty and sixty crosses have been made and in only one of these have the results been such as to indicate that the two defectives which entered the cross were genetically alike. It appears, then, that there are many different factors involved which cause defective seeds in maize. A brief description of several characteristic types follows:

Classification of Defectives

The defectives show varying degrees of development. There are types ranging from those which consist of only a transparent, empty, pericarp with scarcely a trace of endosperm tissue, to others in which the development is but slightly less than normal. There are others, even more extreme, in which the seed develops almost normally but fails to go into the resting stage and germinates on the ear. Between these two extremes are all gradations, and within each type is a certain amount of variation, so that it is often impossible to separate two such types when they occur on the same ear.

The defectives may be roughly classified into three groups as follows:

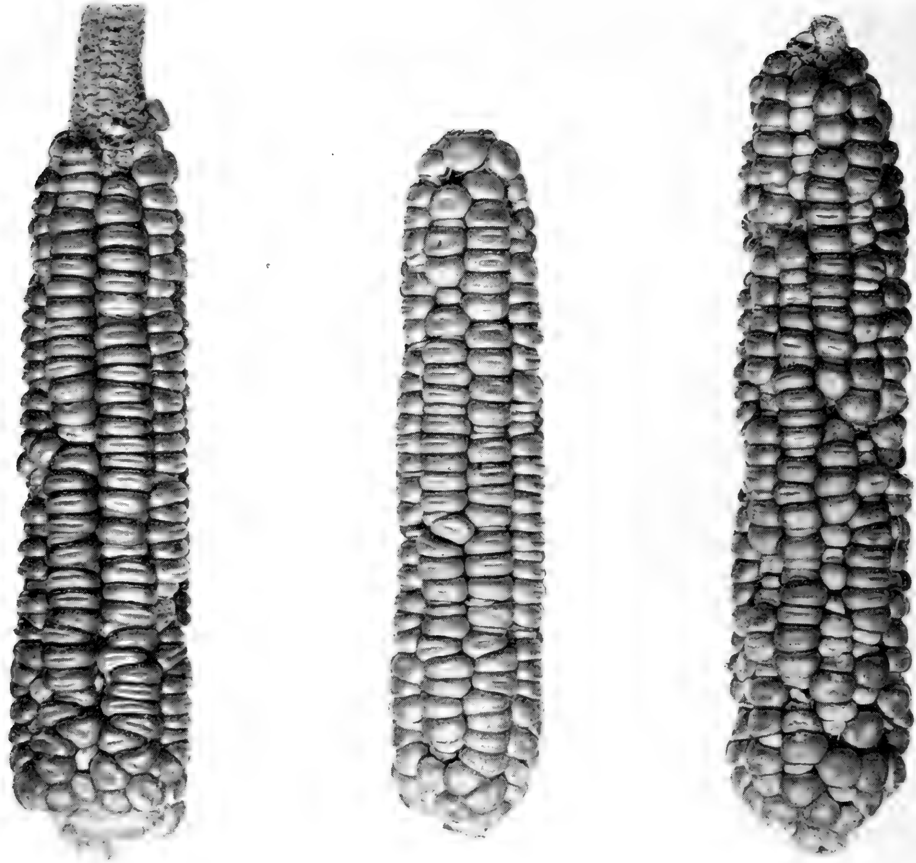
1. Complete defectives; those in which the development of the ovule is arrested shortly after fertilization.

2. Partial defectives; those in which development proceeds until a certain amount of endosperm tissue has been laid down.

3. Germinating seeds; those in which the mature seed fails to go into the resting stage.

[1] Contribution from the Bussey Institution, Harvard University.

[2] Jones, D. F. Heritable Characters of Maize; Defective Seeds. *Journal of Heredity*, vol. xi, No. 4. 1920.



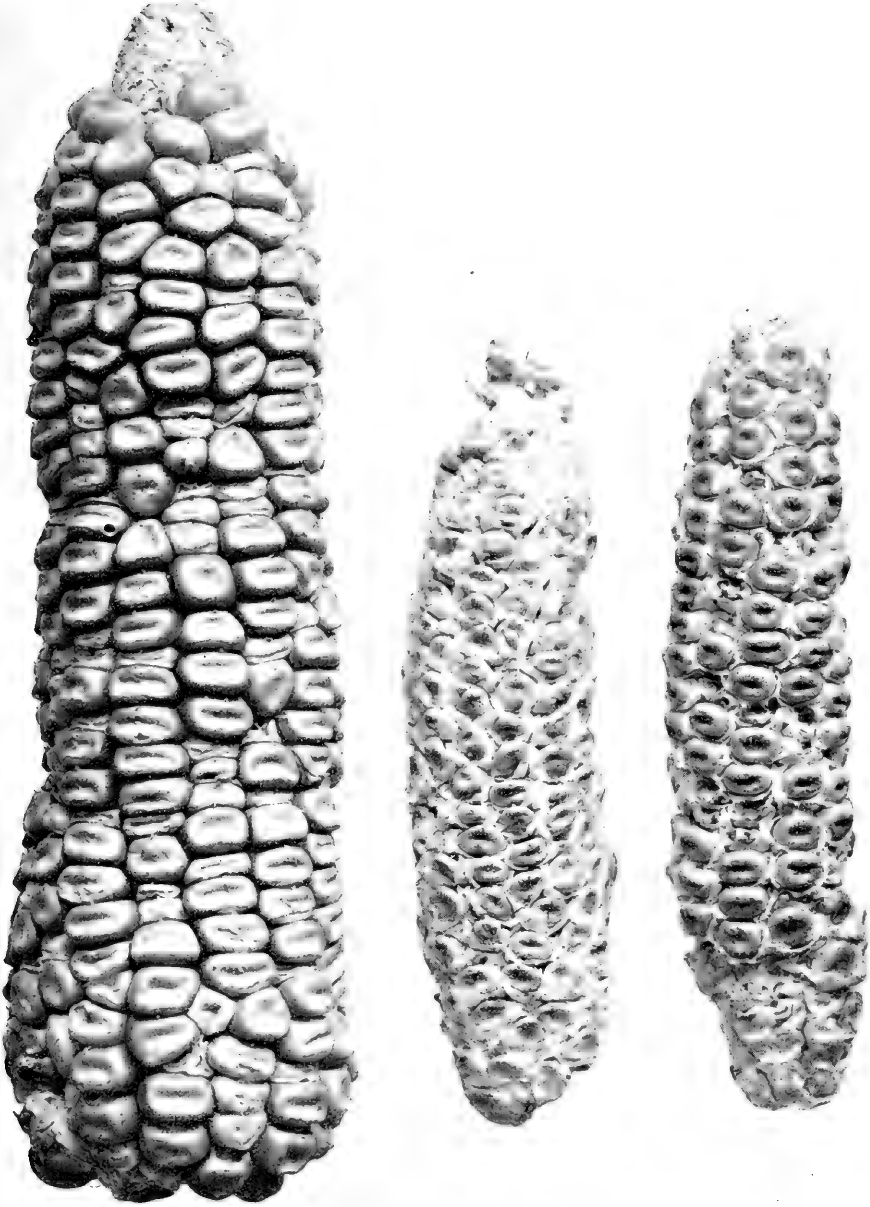
Partial Defective **Complete Defective** **Both Types**

A CROSS BETWEEN TWO TYPES OF DEFECTIVE ENDOSPERM

FIGURE 11. These ears are borne on plants of the first hybrid generation, but because of the phenomenon of double fertilization in maize the endosperm of these grains is of second generation tissue. Only one type of defective grains occurs on some ears, while on others both types are found. On the ears on which both types occur they are in a 9:7 ratio, proving that the two defects are genetically distinct.

Description of Characteristic Types

A typical representative of the first group is one which Jones first observed in a commonly grown New England variety, Century Dent. This particular defective is little more than an empty pericarp, although under certain favorable conditions, it does form a trace of endosperm tissue. The seeds have a very small embryo, scarcely visible except under the microscope, but apparently quite normal in structure. When kept in a germinator at optimum conditions of temperature and moisture, these aborted seeds show a germination of about twelve per cent. The seedlings are extremely weak, as shown in the illustration, and in many cases are unable even to burst through the pericarp. Because of the almost complete absence of an available food supply, these seedlings survive but a few days. It has been possible to prolong their period of development by growing them in a nutrient agar, and it might be possible by grafting



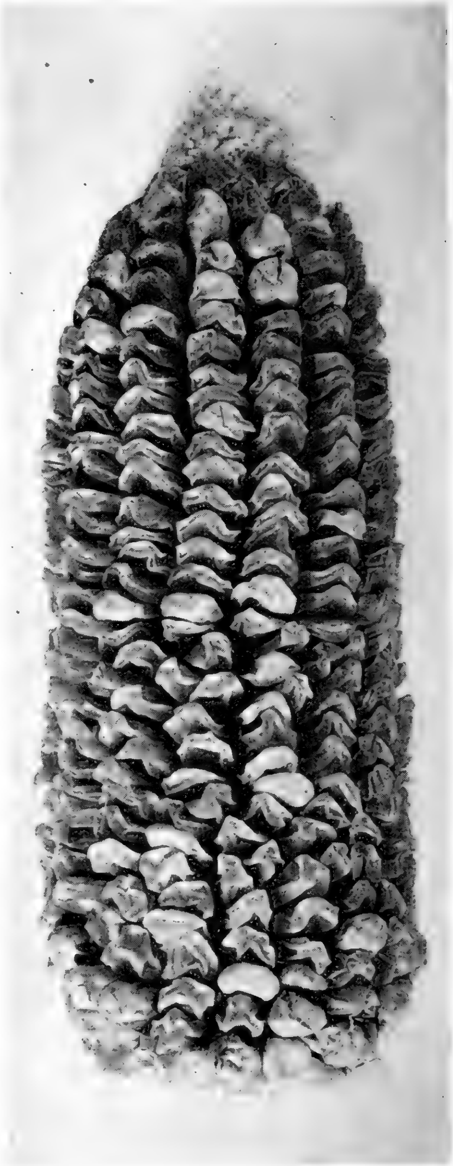
"PURE" DEFECTIVES

FIGURE 12. The lethal action of many of these defects of the endosperm is such that it is impossible to germinate seed, much less to raise homozygous, or genetically pure defectives. However, partial defectives contain enough endosperm so that it is possible to raise plants from such seed. On such plants all of the seeds are defective when the ear is self-pollinated or when cross pollinated with pollen from other defective plants. On the left is an ear segregating for partially defective grains; in the center is a self-pollinated homozygous ear of the "partial defective," and on the right is a cross pollinated ear from such a homozygous plant.

on to a normal endosperm, to bring them to maturity. Such an experiment would show whether the lethal action of the defectives is merely one of an insufficient food supply or whether other factors are involved.

For the second group, a defective which also appeared in the variety Century Dent, is typical. In this type the development of the recessive seeds is halted only after a considerable proportion of the endosperm tissue has been laid down. It is impossible to determine whether a plant is segregating for this defective until the seeds have reached the soft dough stage, while in the case of the type described above the aberrant seeds can usually be identified soon after pollination. The seeds of the partial defective are almost normal in size but lack the lustre of fully developed kernels. The pericarp attains almost complete development and since the endosperm fills it only partially, the defectives have a shrivelled appearance. They are readily distinguished from normal seeds on the same ear and separation of the two types can be very accurately made. The development of the embryo in these abortive seeds is apparently normal in every respect and they show a germination of eighty to ninety per cent under optimum conditions. The seedlings, however, are very weak and under field conditions seldom emerge. Even in the greenhouse most of them die in several weeks. When the most vigorous seedlings are "nursed" along in the greenhouse and later transplanted to the field, it is possible to mature a few plants. An ear from such a homozygous plant is shown in the illustrations. Apparently the lethal action of this defective is purely one of an insufficient food supply.

This partial defective has been crossed with the complete defective which appeared in the same variety and which has already been described. The first generation of such a cross was normal. In the second generation several of the ears were segre-



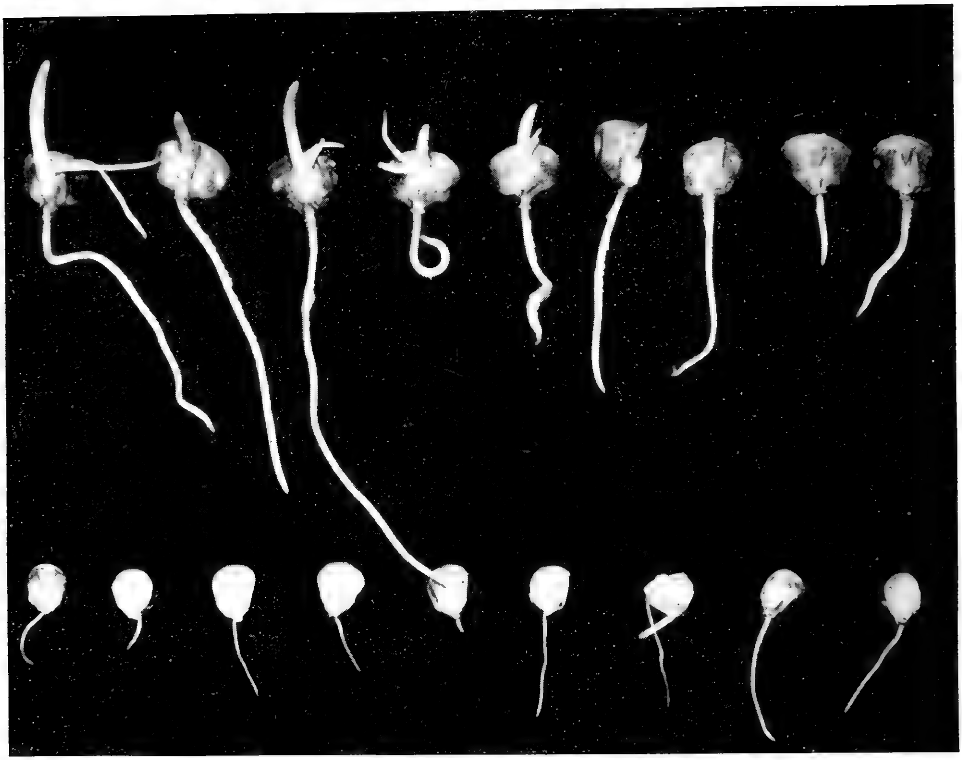
GERMINATING SEEDS

FIGURE 13. This newly discovered type of defective kernels is characterized by the failure of the embryo to go into a resting stage. The growing embryo stretches the pericarp and in extreme cases ruptures it. These grains have a characteristic swollen appearance, and are lighter in color than the other grains on the same ear. When the ear is harvested the embryo in these seeds dies from lack of water.

Normal Seeds | Defective Seeds

SIX TYPES OF DEFECTIVE SEEDS

FIGURE 14. All seeds in each horizontal row are from the same plant. There are many types of defective endosperm in maize, ranging from those which exhibit only a transparent empty pericarp, to those in which development is slightly less than normal. These varying degrees of defectiveness are not the diverse expression of the same hereditary character, but each is inherited as an independent unit. Several of these defects can be brought together on the same ear, when their distinctive characteristics are all retained.



GERMINATION OF NORMAL AND DEFECTIVE SEEDS

FIGURE 15. When kept in an incubator complete defectives show a germination of only about twelve per cent. The illustration shows some of the defectives which have germinated compared with normal grains from the same ear. Unless transferred to nutrient agar the defectives proceed no farther than the stage shown in the photograph.

gating for two types of defectives in approximately a nine-seven ratio, showing that the two types are genetically distinct and not merely the same character associated with different combinations of modifying factors. The two types have also each been crossed with some fifteen other defectives from various sources and appear to be distinct from all of them, although so closely resembling several of them as to be indistinguishable.

The third group of defectives we have called *germinating seeds.* The factor for germinating seeds prevents the mature ovule from going into the resting stage and approximately one-fourth of the seeds on a segregating ear begin to germinate while still attached to the rachis. Usually the embryo grows only enough to stretch the pericarp and give the seed a swollen appearance, but in extreme cases the pericarp is burst and a well-defined root and shoot are formed. The character was first observed by Jones on a self-pollinated ear of a small New England variety, Canada Flint. It is not at all unusual, especially in New England, to find ears in the field on which part of the seeds have germinated. Ordinarily when this occurs the germinating seeds are confined to a local region of the ear which has not dried out thoroughly. On this particular specimen, however, the germinating seeds were scattered at random throughout the ear and oc-

curred in the approximate proportion of three non-germinating to one germinating. The normal seeds from this segregating ear were planted in 1922 and the abnormality again appeared, indicating that it is inherited and not merely the result of environmental conditions. On the other hand, the character is probably one, which, though genetically present, would manifest itself only under certain environmental conditions. In a dry season it might never appear, although the factors for germinating seeds were constantly present.

Germinating seeds have been observed in only two varieties at the Connecticut station and it has not yet been determined whether the two are alike or distinct.

In the variety Canada Flint, there is some relation between germinating seeds and the production of yellow color in the endosperm. The ear on which the germinating seeds were first observed was homozygous for yellow endosperm. The following season all of the germinating seeds were white. The relation is probably a physiological one which has been accentuated by the inbreeding. If it is true genetic linkage, then a mutation for white seeds must have occurred and this mutation is completely linked with the factor for germinating seeds. Another season's result should show definitely whether such is actually the case.

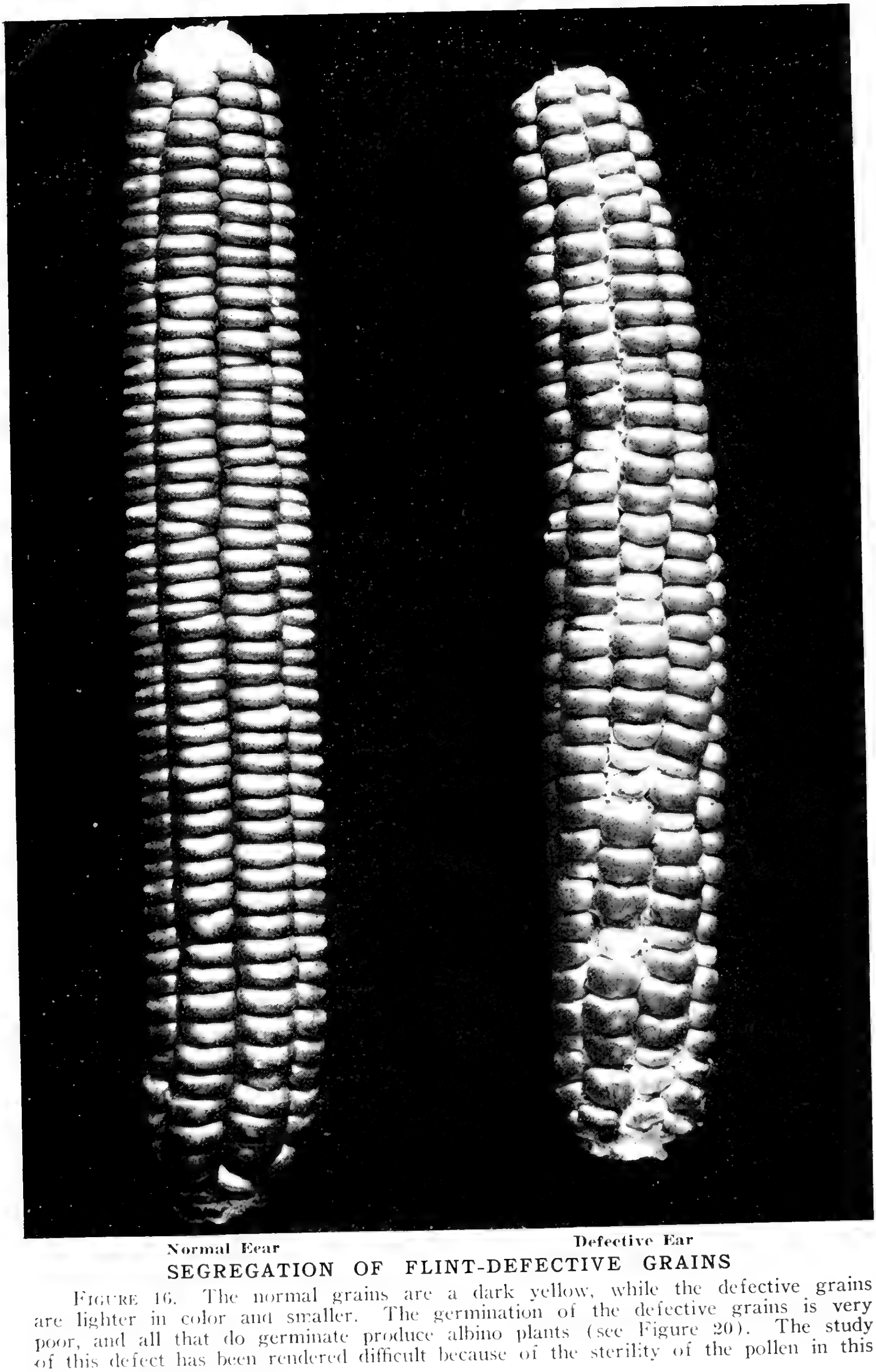
Germinating seeds are just as lethal in action as the other extreme type of defective in which there is no food supply. The aberrant seeds die when the ear is harvested and the moisture supply cut off. It might be possible to transfer the germinating seeds directly to the greenhouse in the fall and mature the character in a homozygous condition during the winter months, but under ordinary field conditions it is a very effective lethal.

Defective Germplasm Wide-Spread

These many types of defective seeds, of which the three here described are typical, are but another example of defective germplasm which may be widespread in any naturally cross-fertilized crop. Almost any field-pollinated ear of corn shows a few defective seeds. Ordinarily, these escape attention, or if noticed, are attributed to the effects of incomplete pollination or other external factors. Some of them no doubt are due to environmental conditions, but many are definitely inherited. It is in the bringing to light of such recessive abnormalities, and in the elimination of inferior germplasm, that inbreeding is of greatest value as a means of permanent improvement.

Genetics in Russia

A LABORATORY of Experimental Zoology and Genetics has been established in Petrograd, under the direction of Professor I. A. Philiptchenko. In Moscow a eugenics society has been organized, which also publishes a bulletin periodically. The cover of this bulletin is ornamented with the portraits of Erasmus Darwin, Charles Darwin and Francis Galton. As Fritz Lenz remarks, in communicating this notice, there is food for thought in the adoption by a Soviet organization of these patrons of science, all three of them representatives of the English landed gentry and owing to inherited wealth their freedom to devote themselves to research in evolution.



Normal Eear　　　　　　Defective Ear

SEGREGATION OF FLINT-DEFECTIVE GRAINS

FIGURE 16. The normal grains are a dark yellow, while the defective grains are lighter in color and smaller. The germination of the defective grains is very poor, and all that do germinate produce albino plants (see Figure 20). The study of this defect has been rendered difficult because of the sterility of the pollen in this inbred strain. See p. 130.

HERITABLE CHARACTERS OF MAIZE

XIII—ENDOSPERM DEFECTS—SWEET DEFECTIVE AND FLINT DEFECTIVE

E. W. LINDSTROM
Iowa State College, Ames.

IN THE course of some inbreeding experiments with maize, certain unusually distinct types of defective kernels were isolated in commercial varieties of sweet and flint corn. These were merely a few of the abnormal types that appear in any naturally cross-fertilized crop like corn whenever inbreeding is practised. These defective kernels are always recessive to the normal kernel type in inheritance. Their recessive nature enables them to persist indefinitely in the heterozygous condition. Dominant types may possibly occur, but obviously such mutants are unable to reproduce their kind, since the defective kernels usually fail to germinate, or produce such weak seedlings that they eventually perish. Thus any dominant mutants that arise fail to pass the defect to succeeding generations.

The most outstanding type of defective grain occurred in an inbred strain of the Golden Bantam variety of sweet corn. This variety is noted for its stability of type, not only in its remarkable quality as a table variety of sweet corn, but also in its morphological characteristics. Its deep yellow endosperm, eight-rowed condition, suckering habit and its earliness are all extremely well impressed on the variety.

Inheritance of the Sweet-Defective Type of Endosperm

In 1919 there occurred a single ear among several hundred self-pollinated ears of a commercial variety of Golden Bantam, which showed an unusually sharp segregation of normal and defective kernels. An actual count gave 134 normal and 50 defective grains.

These off-type kernels possessed a small, stunted embryo and about half the usual amount of endosperm. In the roasting-ear stage, the defective kernels were almost as plump as the normal but they showed a peculiar mottling of brown in the endosperm (Figure 17). On drying, they shrink to about half the normal size and are a brownish-gray in color (Figure 18). Samples were given to the plant pathologist for culture to detect any causal organism, but none was found. Germination tests proved that these kernels would not sprout.

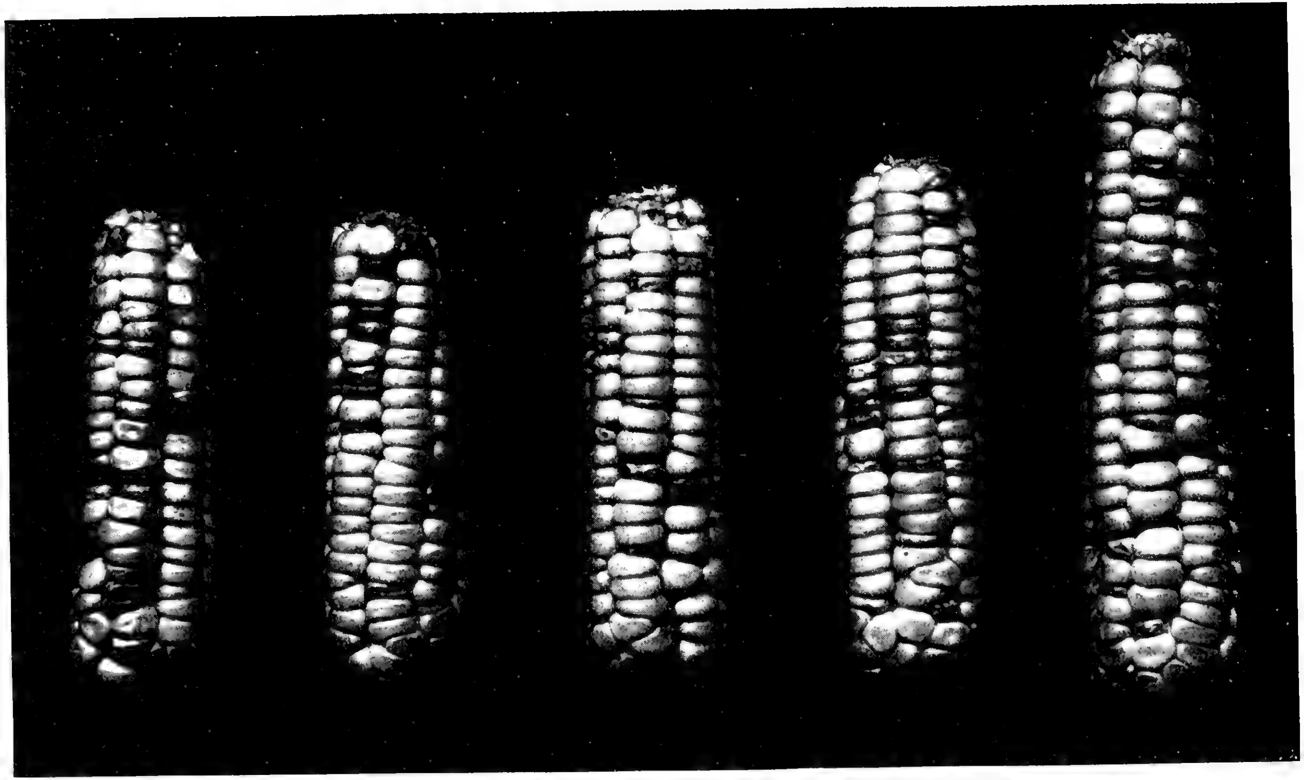
The normal grains of the original ear were planted in 1920. The harvest showed a distinct recurrence of the defective grains. Normal grains of this 1920 crop were planted in the following year with a similar result.

The experimental data for these two years have been arranged in Table 1.

Two sorts of progenies were found among all the self-pollinated ears coming from normal grains of a segregating ear. If this hereditary defect is caused by a simple, recessive Mendelian factor, we should expect that one sort would show ears with nothing but normal kernels, while the other sort would comprise ears with seventy-five per cent normal and twenty-five per cent defective grains.

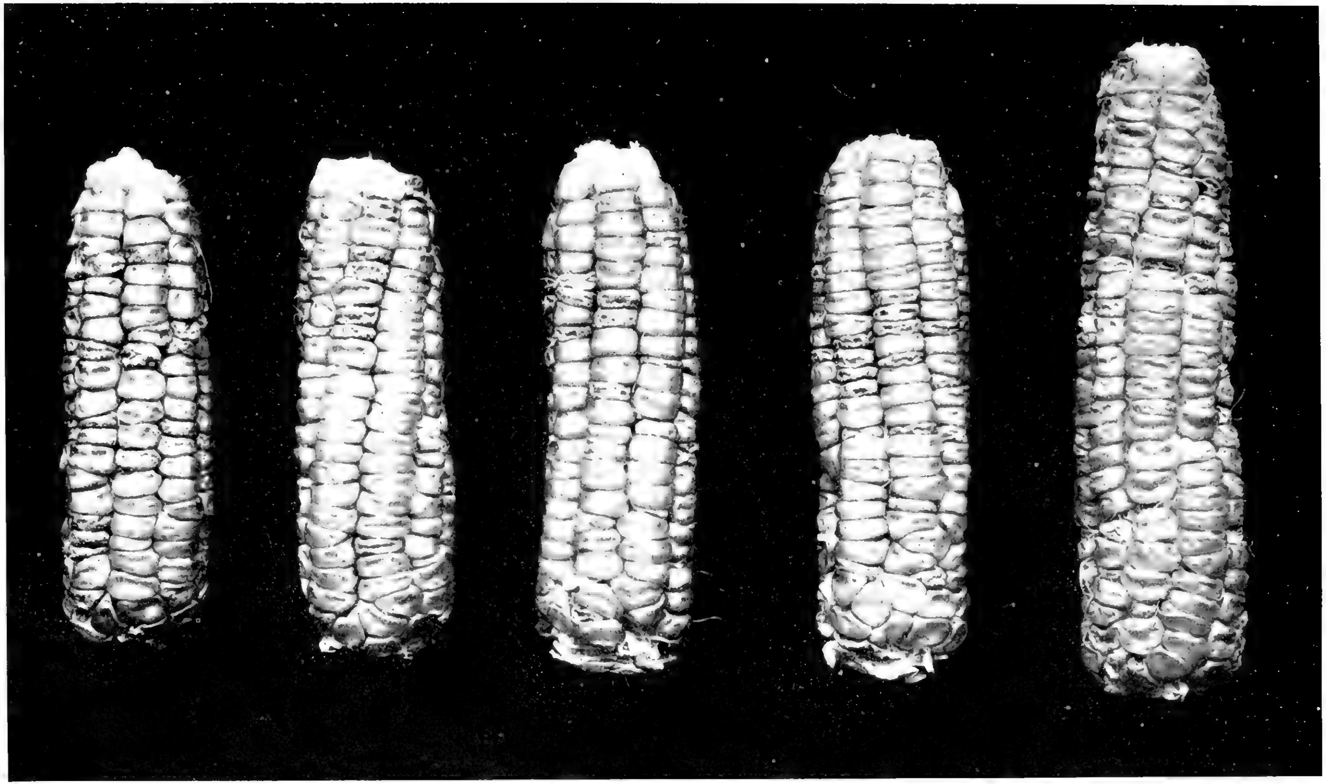
This is what actually happened as can readily be seen in Table 1. The

[1] Paper No. 1 from the Department of Genetics, Iowa State College, read at the Boston meeting of the A. A. A. S., December 28, 1922.



SWEET-DEFECTIVE GRAINS ON IMMATURE EARS OF GOLDEN BANTAM CORN

FIGURE 17. In the roasting-ear stage the defective grains are somewhat smaller than the normal grains, and have a peculiar mottled brown endosperm. The hereditary defects of the endosperm of maize are very numerous, and many distinct kinds have been isolated. Necessarily these defects are recessive, as in nearly all cases they prevent the development of the young plant, and so act as a lethal factor. A dominant defect of the endosperm might appear by mutation, but it would be automatically self-eliminating in the next generation. A recessive defect, however, is masked when in the heterozygous or latent condition, and only appears when pure. Thus these defects are rarely found when maize is cross-pollinated in field culture.



SWEET-DEFECTIVE GRAINS ON DRIED EARS

FIGURE 18. These are the same five ears shown in Figure 17. The defective grains become more wrinkled, since they shrink more than the normal ones, and their color changes to a brownish-grey. The manner of inheritance of this defect was studied in two ways, by counting the number of normal and defective kernels on the ears segregating for the defect, and by a progeny test: plants from the normal grains of segregating ears were self-pollinated, and some were found to segregate for the defect, while others were not. A count of the segregating and non-segregating plants gave a result that almost exactly agreed with theoretical expectation, were the character controlled by a single Mendelian factor, recessive to normal development.

ratios of the individual ears that are heterozygous are in accord with the 3:1 proportion. The total count of thirty-one segregating ears resulted in 4544 normal and 1390 defective grains. There was a slight deficiency of the latter, which may be due to the difficulty of detecting every defective kernel on an ear since some of them are very small and may be easily overlooked. It is entirely possible, however, that this consistent deficiency of the defective kernels may be accounted for by differential pollen tube growth.

However, the best test of the situation is the progeny test, since in this case there is absolutely no difficulty in classifying a normal ear from one that is segregating for the two types of kernels. Such a progeny test appears in Table II.

There were actually fifteen ears with nothing but normal grains and thirty-one with the two kinds of grains. This is as close to the expected results as possible, and it proves that the defective kernel-type of this Golden Bantam variety is controlled by a simple, Mendelian factor.

One of the ears of the last season's harvest (5016-11) presented a very noticeable deviation from all others. It had a higher proportion of defective kernels than any other ear. Besides 112 normal and 44 defective kernels there were 37 kernels that showed a peculiar white appearance (Figure 19). This is especially remarkable since in the three years of inbreeding of this variety, never did any white endosperm occur. These kernels were also of a defective type, but distinctly different from the other. Not only was this new type white in appearance, but there was a marked tendency for the germ to commence growth on the ear. The growth of the embryo consisted mainly of an elongation of the primary root which attained the length of about one-half inch or less within the seed coat. When the grains dried out at maturity the entire embryo turned brown and died. The details of the inheritance of this new type (or mutation) are not known as yet.

Inheritance of the Flint-Defective Type of Endosperm

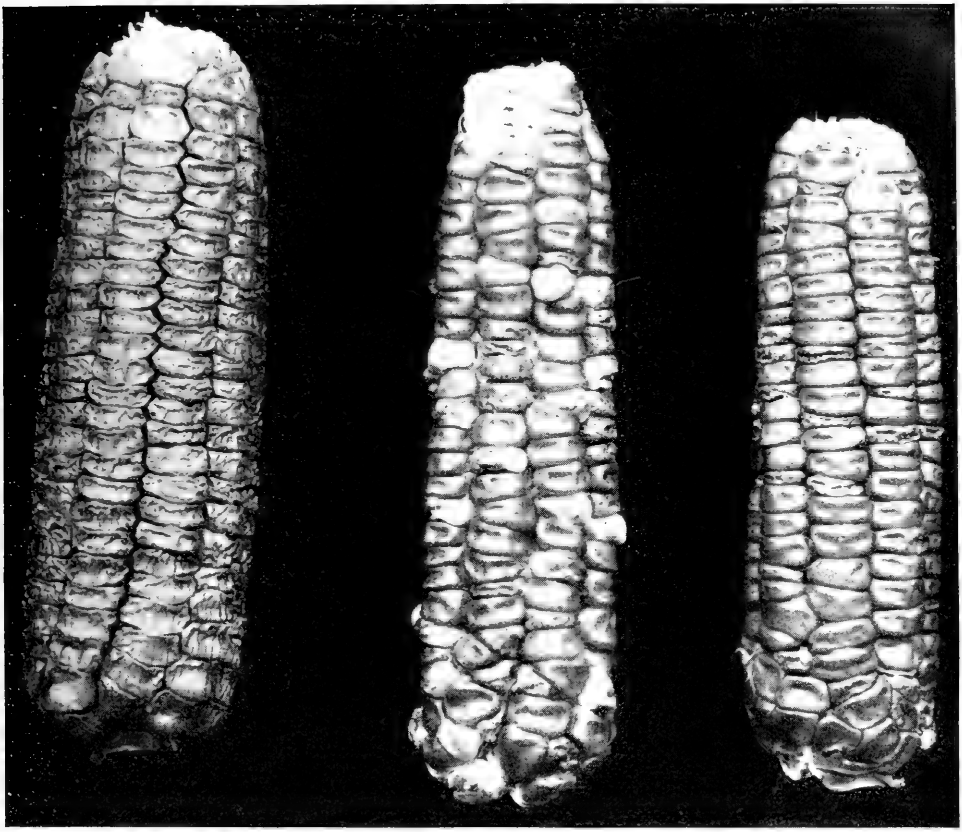
Another type of defective kernel arose in some inbred strains of a yellow flint variety, which originally came from Massachusetts. According to Dr. W. E. Castle who sent the original seed to the writer, the variety name was Stickney, being most likely a selection from Longfellow Flint.

In this case, certain inbred ears exhibited a distinct segregation into normal and defective kernels. The latter are distinctly a pale yellow color, contrasting sharply with the dark yellow color, typical of the variety. This color distinction is enhanced by the difference in endosperm texture. While the normal seeds are characteristically hard and flinty, the defective kernels are dull and starchy in appearance, and somewhat smaller in size (Figure 16).

The germination of the defective kernels is very poor. But the striking thing is that whenever they do germinate, they produce white or albino seedlings. The photograph (Figure 20) of the seedling flat shows the situation very well. When the normal seeds of the segregating ear are planted separately from the defective kernels, the former produce green seedlings while the latter throw pure whites. The alternate rows in the flat show this very distinctly.

A study of the inheritance of this flint-defective endosperm has been rendered very difficult by reason of a large amount of pollen sterility in this inbred strain. Self-pollinated ears are obtained only with great difficulty. Cross-bred ears are easily made, showing that the ovules are fertile.

The original ear (2258-5) showing this abnormal endosperm characteristic was one of a large family that was heterozygous for white and pale yellow seedlings, which were in every way typical of the ordinary seedlings showing such chlorophyll defects. This fact



Normal Ear — Segregating for the New Defect — Segregating for Sweet Defective

DEFECTIVE KERNEL TYPES IN INBRED GOLDEN BANTAM SWEET CORN

FIGURE 19. In addition to the sweet-defective endosperm studied for two generations in this inbred strain, another entirely distinct defect appeared in the third generation, remarkably similar to that described by Mangelsdorf in another variety of sweet corn (see Figure 13). In this case the appearance of the defect would seem to be due to mutation, as it was absent in the preceding inbred generations. (See page 130.)

leads us to suppose that the white seedlings so closely associated with the defective kernels are genetically identical with the ordinary type and are not fundamentally due to the defect in the kernel itself. Scores of crosses were attempted to check this, but the sterility involved in this variety prevented any success.

The inheritance of this defective endosperm character was studied by means of planting the normal grains of self-pollinated ears that were segregating for normal and defective kernels. The individual plants arising from such normal kernels were in turn self-pollinated. This was done for two growing seasons. Counts of thirty ears thus produced are presented in Table III.

Of these thirty ears, six showed no defective grains (from homozygous normal seeds), and twenty-four had both normal and defective grains on the ear (from heterozygous seeds). If the genetic factors governing the inheritance of this allelomorphic pair (normal-defective) of characters is a simple one, we should expect a proportion of ten homozygous to twenty heterozygous

ears instead of six and twenty-four, as was actually the case. This is not an especially close approximation to theory, although the deviation (4) is only 2.3 as large as the probable error.

Some of the individual ears that segregated for the two kernel types exhibit considerable deviation from a 3:1 ratio. This was noticeably true of the poorer ears which always seemed to possess less than twenty-five per cent, defective kernels. The better developed ears, those with the larger number of kernels, do not depart very greatly from the expected 3:1 proportion, although there is still a slight deficiency of the defective kernels. The total of all the ears approaches a 3:1 ratio, but in this case the deficiency of defective kernels in the poorly developed ears is magnified. However, the totals are not entirely beyond the limits of a simple, single-factor hypothesis.

The seedling data from the thirty self-pollinated ears show one or two points of interest. In the first place, all the ears that were normal in endosperm (total of six) produced not a single white seedling. This fact is a strong indication that there is a complete association, correlation, or linkage between green seedlings and normal endosperm (or white seedlings and defective endosperm). Otherwise we might expect occasionally a normal ear to produce three green to one white seedling, as was the case in the original grand-parental stock.

The seedling progenies from the twenty-four ears that possessed both normal and defective kernels exhibit some interesting facts (Table IV). In every case the normal grains from such ears were planted separately from the defective ones. The percentage of germination of the latter was very poor. A noteworthy fact is that the second generation progenies (pedigree numbers 4122, 5009 and 5010) showed a far smaller per cent. of germination than the original ear and the first generation from it (3354). The reason for this is unquestionably due to the fact that the mother ears of the second generation were those chosen because of the distinctness of their defective kernels. This means that a smaller defective kernel type was selected, which gave a progeny that reproduced this characteristic, thereby possessing less endosperm and less ability to germinate.

A glance at Table IV shows at once that the seedlings coming from normal grains of heterozygous ears were green in the great majority of cases. Conversely those coming from defective seeds were white, with a few exceptions.

In the first generation from the original ear a greater number of exceptions occur than in the second generation (pedigree numbers 5009 and 5010 especially). For this reason it is logical to suppose that the exceptions noted can most easily be attributed to mistakes in classifying the grains into normal and defective. Where this classification is more distinct, as is the case in later progenies (5009 and 5010), the exceptions are very rare. Accordingly it seems plausible that the so-called exceptions are not due to genetic crossovers of the linkage between the chlorophyll and endosperm factors involved. This may be a case of a very close but not complete linkage, although that does not seem very reasonable.

These two types of abnormal kernels, the sweet-defective and flint-defective, are distinctly different from the abortive type reported several years ago.[1] In the abortive type there is a complete failure of endosperm development. Both the defective and abortive types have been found in several inbred strains of dent corn. Apparently these are similar to those reported by Jones.[2] There appear to

[1] Lindstrom, E. W. Chlorophyll Factors of Maize. *Journal of Heredity,* **11**:269-277. 1920.

[2] Jones, D. F. Heritable Characters of Maize, IV. A Lethal Factor—Defective Seeds. *Journal of Heredity,* **11**:161-167. 1920.

SEEDLINGS FROM FOUR SELF-POLLINATED EARS SEGREGATING FOR FINT DEFECTIVE KERNELS, SHOWING LINKAGE

FIGURE 20. When the defective grains of flint corn (Figure 16), are grown separately from the normal grains from the same ear, a striking difference appears in the seedlings. Above are shown alternate rows of seedlings from normal grains, and from flint-defective ones. All those from defective seeds have produced albino plants. Relatively very few of the defective seeds have sprouted, and even at this early stage the albino seedlings are evidently at a disadvantage as compared with the normal ones. As the plants grow older the difference will become greater. The albinos eventually will starve to death, as the absence of chlorophyll makes it impossible for them to manufacture food from sunlight and the elements drawn from air and soil.

be several different genetic types of defective and abortive endosperm. It so happens that this material does not exhibit such clean-cut types as those reported in this article. Another year's work, in which the secondary modifiers influencing the kernel type are rendered pure, is necessary.

Recent work is proving that the endosperm of maize is but another example of a qualitative, heritable character that is dependent on a large number of genetic factors for its development. Besides the factors that control the physical texture of the endosperm such as the sweet, flint, dent, pop, floury and waxy factors, we must now add at least a half-dozen others that control directly the formation and complete development of the endosperm itself. The recessive allelomorphs of these might be classed as lethal or semi-lethal factors for endosperm development.

The general situation is similar to that of another characteristic of the corn plant. Chlorophyll, for example, is a distinct genetic character that is now known to involve at least twenty separate genetic factors, ranging from

those that are completely lethal (such as produce white seedlings) to those that are non-lethal, producing merely a pale or light green plant. These discoveries are pointing clearly to the fact that while the hereditary units (factors or genes) themselves are apparently discontinuous units or entities, they are so numerous and often their effects are so minute that they appear to present a continuous series when viewed as a whole. But inasmuch as we can isolate and study any one of these numerous factors, their actual unity is proven when they fall into a definite system of heredity, as they actually do.

Summary

An endosperm defect in sweet corn, called sweet-defective, which arose in an inbred Golden Bantam strain is proven to be inherited as a simple, Mendelian recessive.

A distinct mutant involving another endosperm defect arose in the third inbred generation of the Golden Bantam strain. Evidence indicates that this could not have been in the stock in previous years.

Another recessive endosperm defect was discovered in yellow flint corn. This flint-defective type shows complete linkage with albino seedlings.

TABLE I—*Showing progenies from normal kernels of self-pollinated ears that were segregating for sweet-defective grains.*

Pedigree No. of Selfed Ear	Normal	Defective
Original Ear	134	50
4264-5	all	..
4264-7	117	38
4264-8	all	..
4264-11	135	37
4264-14	120	30
4264-17	87	24
Sub-total	459	129
Theoretical	441	147
5015-1	148	41
5015-2	178	71
5015-3	all	..
5015-4	all	..
5015-5	171	52
5015-6	all	..
5015-7	all	..
5015-8	131	39
5015-9	all	..
5015-16	162	68
5015-18	179	51
5015-19	150	48
Sub-total	1119	370
Theoretical	1117	372
5016-1	all	..
5016-3	all	..
5016-4	139	44
5016-5	121	48
5016-6	all	..
5016-8	123	31
5016-9	all	..
5016-10	147	48
5016-11	149	44
5016-12	180	55
5016-13	139	38
5016-14	all	..
5016-15	148	43
Sub-total	1146	351
Theoretical	1123	374
5017-1	all	..
5017-2	207	57
5017-3	all	..
5017-4	143	44
5017-5	135	38
5017-6	159	45
5017-7	121	43
5017-8	141	48
5017-9	116	35
5017-11	174	49
5017-12	152	44
5017-14	all	..
5017-15	146	47
5017-18	192	40
Sub-total	1686	490
Theoretical	1632	544
Grand Total	**4544**	**1390**
Theoretical	**4451**	**1484**

TABLE II. *Showing proportion of homozygous and heterozygous genotypes tested by progenies derived from self-pollination.*

Pedigree No. Mother Plant	Pedigree No. of Progeny	No. Progenies That Were Homozygous	Heterozygous
Golden Bantam selfed	4264	2	4
Golden Bantam selfed	5015	5	7
4264-11	5016	5	8
4264-14	5017	3	12
Total		15	31
Theoretical		15.3	30.7

TABLE III. *Showing self-pollinated progenies from normal grains of ears that segregated for normal and flint-defective kernels.*

Pedigree No. of Selfed Ear	Normal	Defective	Origin
3354-1	189	60	From 2258-5
3354-2	119	23	
3354-5	228	68	
3354-9	all	..	
3354-10	162	55	
Sub-total	698	206	
Theoretical	678	226	
4122-2	187	66	From 3354-1
4122-6	34	11	
4122-11	78	19	
4122-18	40	8	
4122-24	47	9	
Sub-total	386	113	
Theoretical	364	125	
5009-3	75	17	From 3354-1
5009-4	227	70	
5009-5	all	..	
5009-10	94	22	
5009-13	230	69	
5009-17	208	80	
5009-18	93	25	
5009-20	217	50	
5009-21	all	..	
5009-23	264	81	
5009-25	124	30	
5009-26	223	89	
5009-27	all	..	
5009-28	155	30	
Sub-total	1910	563	
Theoretical	1855	618	
5010-1	234	84	From 4122-2
5010-8	196	66	
5010-9	191	65	
5010-13	all	..	
5010-17	225	74	
5010-24	all	..	
Sub-total	846	289	
Theoretical	851	204	
Grand Total	**3840**	**1171**	
Theoretical	**3759**	**1253**	

TABLE IV. *Results of seedling progeny tests from self-pollinated ears showing the linkage between white seedlings and flint-defective grains.*

Pedigree No. of Selfed Ear	From Normal Grains *Green*	*White*	From Defective Grains *Green*	*White*
3354-1	150	1	0	18
3354-2	69	2	0	18
3354-5	186	10	1	66
3354-10	113	2	6	25
Sub-total	518	15	7	127
4122-2	118	0	0	7
4122-6	27	0	0	4
4122-11	43	3	0	8
4122-18	23	1	0	3
4122-24	33	0	0	3
Sub-total	244	4	0	22
5009-3	14	0	0	1
5009-4	26	0	0	0
5009-10	20	0	0	0
5009-13	20	0	0	4
5009-17	27	0	0	0
5009-18	10	0	0	2
5009-20	15	0	0	0
5009-23	20	1	0	6
5009-25	25	0	0	0
5009-26	26	0	0	0
5009-28	23	0	0	0
Sub-total	226	1	0	13
5010-1	25	0	0	0
5010-8	23	0	0	0
5010-9	11	0	0	0
5010-17	32	0	0	2
Sub-total	91	0	0	2

INTERNAL SECRETIONS AND ACQUIRED CHARACTERS

A Review

HORMONES AND HEREDITY, by J. T. CUNNINGHAM. Pp. xx + 246. New York. The Macmillan Company. 1921.

While the chief object of the volume is, in the author's words, "to discuss the relations of modern discoveries concerning hormones or internal secretions to the question of the evolution of adaptations, and on the other hand to the results of recent investigations of Mendelian heredity and mutations," it reviews a wide range of subjects, many of which are but remotely if at all connected with hormones. Thus, the following topics are discussed: Historical Survey of Theories or Suggestions of Chemical Influences in Heredity; Classification and Adaptation; Mendelism and the Heredity of Sex; Influence of Hormones in Development of Somatic Sex-characters; Origin of Somatic Sex-characters in Evolution; Mammalian Sexual Characters; Evidence Opposed to the Hormone Theory; Origin of Non-sexual Characters; The Phenomena of Mutation; Metamorphosis and Recapitulation.

From time to time throughout the work an irascibility is evinced toward Mendelism, but just why, one is unable to determine from any analysis submitted in the text. The supposed difficulties mentioned appear to the reviewer, at least, to be largely false issues which are adequately accounted for by the modern factorial hypotheses of Neo-Mendelists. Various of the other difficulties which are cited by the author as outstanding, have been discussed and shown to be at least not necessarily in disharmony with Mendelism by Morgan, in his *Heredity and Sex,* published in 1913—a volume with which Cunningham appears to be unacquainted.

The book, in the main, is an elaboration and defense of the author's earlier Lamarckian theory of the origin of secondary sexual characters in relation to hormones, although the theory is extended to other adaptive structures and to certain types of non-sexual characters. His central idea appears to be that any over- or under-production of hormones may stimulate the appropriate "determinants" in the genital cells and modify them correspondingly. The author avows his adherence to the idea of continuous variation (fluctuations) in the Darwinian sense as distinguished from mutations, but apparently his conception of mutations is the older one which regards them as changes of considerable magnitude, rather than the modern one which admits of any degree of minuteness. Recognizing as do all modern naturalists that the origin of species and the origin of adaptations respectively are two distinct problems, he attempts to account for the latter on the basis of hormonic influences.

In his own words:

> My view is, then, that specific characters are usually not adaptations, that other characters of taxonomic value are some adaptive and some unrelated to conditions of life, and that while non-adaptive characters are due to spontaneous blastogenic variations or mutations, adaptive characters are due to the direct influence of stimuli, causing somatic modifications which become hereditary, in other words, to the inheritance of acquired characters.

Since to do justice to the author's ideas it seems safest to set them forth in his own phraseology, the reviewer has chosen the following representative passages which indicate the trend of the argument.

> The fact that a hormone from the testis affects the development of the antler, as well as our knowledge of hormones in general,

suggests a special theory of the heredity of somatic modifications due to external stimuli. Physiologists are apt to look for a particular gland to produce every internal secretion. But the fact that the wall of the intestine produces secretion, which carried by the blood causes the pancreas to secrete, shows that a particular gland is not necessary. There is nothing improbable in supposing that a tissue stimulated to extensive growth by external irritation would give off special substances to the blood. We know that living tissues give off waste products, and that these are not merely pure CO_2 and H_2O, but complicated compounds. The theory proposed by me in 1908 was that we have within the gonads numerous gametocytes whose chromosomes contain factors corresponding to the different parts of the soma, and that these factors or determinants might be stimulated by waste products circulating in the blood and derived from the parts of the soma corresponding to them. There is no reason to suppose that an exostosis formed on the frontal bone as a result of repeated mechanical stimulation due to the butting of stags would give off a special hormone which was never formed in the body before, but it would probably in its increased growth give off an increased quantity of intermediate waste products of the same kind as the tissues from which it arose gave off before. These products would act as a hormone on the gametocytes, stimulating the factors which in the next generation would control the development of the frontal bone and adjacent tissues.

The difficulty of this theory is one which has occurred to biologists who have previously made suggestions of a connexion between hormones and heredity—namely, how hormones or waste products from one part of the body could differ from these from the same tissues in another part of the body. If there were no special relation, hypertrophy of bone on one part of the body such as the head would merely stimulate the factor for the whole skeleton in the gametocytes, and the result would merely be an increased development of the whole skeleton. On the other hand, we have the evident fact that a number of chromosomes formed apparently of the same substance, by a series of equal chromosome divisions determine all the various special parts of the complicated body. This is not more difficult to understand than that every part of the body should give off special substances which would have a special effect on the corresponding parts of the chromosomes. We know that skin glands in different parts of the body produce special odors, although all formed of the same tissues and all derived from the epidermis. It seems not impossible that bones of different parts of the body give off different hormones. If the factors in the gametes were thus stimulated they would, when they developed in a new individual, produce a slightly increased development of the part which hypertrophied in the parent soma. No matter how slight the degree of hereditary effect, if the stimulation was repeated in every generation, as in the case of such characters as we are considering it undoubtedly was, the hereditary effect would constantly increase until it was far greater than the direct effect of the stimulation.

Again, referring to the origin of the phenomena of the shedding and regrowth of antlers, he has this to say:

The annual shedding and recrescense of the antler, however, is only to be understood in connection with the effect of the testicular hormone. According to my theory there are two hormone actions, the centripetal from the hypertrophied tissue to the corresponding factor in the gametocytes, and the contrifugal from the testis to the tissue of the antler or other organ concerned. The reason why the somatic sexual character does not develop until the time of puberty, and develops again each breeding season in such cases as antlers, is that the original hypertrophy due to external stimulation occurred only when the testicular hormone was circulating in the blood. The factor in the gametocytes then was in each generation acted upon by both hormones, and we must suppose that in some way the result was produced that the hereditary development of the antler in the soma only took place when the testicular hormone was present. It is to be remembered that we are unable at present to form a clear conception of the process of development, to understand how the simple fertilized ovum is able by cell-division and differentiation to develop into a complicated organism with organs and characters predetermined in the single cell which constitutes the ovum. If we accept the idea that characters are represented by particular parts of the chromosomes, according to Morgan's scheme, our theory of development is the modern form of the theory of preformation. When in the course of development the cells of the head from which the antlers arise are formed, each of these cells must be supposed to contain the same chromosomes as the original ovum from which the cells have descended by repeated cell-division. The factors in these chromosomes corresponding to the forehead have been stimulated while in the parent animal by hormones from the outgrowth of tissue produced by external mechanical stimulation, while at the same time they were permeated by the testicular hormone produced either by the gametocytes themselves or by interstitial cells of the testis. When the head begins to form in the process of individual development, the factors, accord-

ing to my theory, have a tendency to form the special growth of tissue of which the incipient antler consists, but part of the stimulus is wanting, and is not completed until the testicular hormone is produced and diffused into the circulation—that is to say, when the testes are becoming mature and functional.

I do not claim that this theory is complete—it is impossible to understand the process completely in the present state of knowledge—but I maintain that it is the only theory which affords any explanation of the remarkable facts concerning the influence of the hormones from the reproductive organs on the development of secondary sexual characters, while at the same time explaining the adaptive relation of these characters or organs to the sexual habits of the various species.

The author makes various digressions from time to time to show how, in his opinion, various adaptive features can have arisen as a result of Lamarckian factors. The explanations suggested are invariably ingenous and interesting, if not always convincing. He uses the term hormone, it should be pointed out, in a much broader sense than is warranted by our actual knowledge, inasmuch as indisputable evidence of the existence of such internal secretions is as yet confined to the products of relatively few organs.

The book is too diverse in its scope to permit of concise summarization. As a whole, it is an interesting discussion, interspersed with bits of information which are of value to biologists, particularly those interested in the problems of evolution, individual development, and secondary sexual characters.

It will be difficult, indeed, for the author to persuade the majority of geneticists today that (p. 55), "The Mendelian theory is merely a theory in words, which have an apparent relation to the facts, but which when examined, do not correspond to any real conceptions," or to lead them to believe (p. 129) that, "There is a tendency among Mendelians and mutationists to overestimate the importance of experiments in comparison with reasoning, either inductive or deductive."

To the reviewer, the grounds advanced for the author's theory are suggestive rather than conclusive, and they will doubtless remain so for many biologists until more definite experimental evidence is forthcoming.

M. F. Guyer,
University of Wisconsin.

For Those About to Marry

Die Gattenwahl, ein artzliches Ratgeber bei der Eheschliessung, by Dr. Max Hirsch. Pp. 42. Price, 20c. Leipzig, Curt Kabitsch Verlagsbuchhandlung, 1922.

Dr. Hirsch, editor of the Archiv fur Frauenkunde und Eugenetik, has attempted the useful task of furnishing in a brief and simple form such information regarding hereditary defects and infectious diseases as might be useful to one about to marry. Besides describing the bearings on marriage of the principal physical and mental maladies, he considers such related subjects as alcoholism. A concluding section urges on all candidates for marriage the desirability of a thorough medical examination. A similarly practical and inexpensive booklet in the English language ought to be available.—*P. P.*

THE ALLEGHENY COLLEGE BIRTH RATE

H. R. Hunt
University of Mississippi

(Continued from the May Number)

THE difference in family size per married alumnus in the two periods is .29 ± .20 children. A chance difference of this magnitude will occur 33 times out of every 100. The difference is therefore not statistically significant; it may have been due to chance. It should be recalled, however, that the living graduates in the period 1870-1884 are a more highly selected group from the standpoint of length of life than those in the period 1885-1899. Therefore the average fecundity in the earlier group may have been higher than that in the later one, because the long-lived men have the larger families. Had both groups been equally selected for longevity, the difference in family size might have been still less.

The difference between the two periods in the average number of children per male graduate is .30 ± .19. This difference is likewise not significant statistically. But married alumni with incompletely reported families have been excluded in Table 5. If the number of unmarried individuals in this computation is reduced so that the percentage of unmarried is the same as in the whole data derived from the questionnaire (8% and 11% for the periods 1870-1884, 1885-1899, respectively), then the two averages will be 2.69 (1870-1884) and 2.36 (1885-1899). The percentage of married individuals among the women graduates reported in the questionnaires is not far, it will be recalled, from the percentage among all the women graduates as reported in the Alumni Register. This was true whether reporting women with incompletely reported families be excluded or included in making the computation. In other words, the questionnaire provided a fair sample of the women as far as the proportions of married and unmarried persons were concerned. Our sample of men is therefore probably representative in the same respect. All available data, therefore, indicate that the numbers of unmarried men we have used in computing the "Children per male graduate" in Table 5 are not far from what they would have been had accurate determinations of percentages of married men in the whole body of graduates been available for use.

The data shown in Table 5 do not meet all the requirements of a rigorous analysis. If the wife is now dead or divorced, the alumnus may marry again and have more children by the second wife. In cases where the wife is less than forty-five years of age, the family may yet increase in size because the mother is still capable of bearing children. The averages in Table 6 are based on families in which (1) the husband (a graduate) is dead (13 cases), and (2) families in which both husband (a graduate) and wife are living, but the wife is not divorced and is 45 years old or older.

The difference between the mean number of children of married alumni in the two periods is .24 ± .22. This difference is not statistically significant. It may have been due to chance. Had the two groups been subjected for equal lengths of time to lethal selection, the difference might have been even less, as pointed out for Table 5.

The divergence between the average numbers of children per male graduate, .29 ± .22, is likewise not statistically significant. The percentages of unmarried persons used in making these computations are the same as in the whole data obtained in the question-

naires for the two periods. If the ratio between the married and the unmarried persons used in the computations be made the same as in Table 5, the averages are 2.63 children (1870-1884), and 2.36 (1885-1899).

It is clear that there has not been a considerable or significant decrease in the size of the families within the group studied.

The Families of Clergymen

The Allegheny College statistics furnish a limited opportunity for a study of the families of clergymen. The College has always been strongly religious. Many of its alumni are ministers. Some of them hold, and have held, high offices in the Church. Table 7 summarizes the data for these men. There are college presidents, a Y. M. C. A. worker, a missionary, and so forth, but all except eight are known to have been actively engaged in the Christian ministry. Of the married individuals, only those are tabulated whose total number of children to date, dead and living, was furnished by the questionnaires.

A second computation of the average number of children per family was made, discarding all cases where the wife is dead or younger than 45 years. The average for the earlier period was 4.7 children (19 families), and 3.1 (25 families) for the later period.

Compare Table 7 with Tables 3, 5 and 6. The most striking feature brought out by this comparison is the somewhat larger size of minister's families, especially for the classes of 1870-1884. The superiority of the clergymen almost disappears, however, in the second period. The drop in the size of the families by an average of over one and a half children each, suggests that voluntary limitation came into vogue among the individuals of the later period.

c. The third and most important question is, has the group under observation produced enough children to replace itself? Will the number of children who reach early manhood, the approximate age at which their parents graduated from college, be less, equal to, or greater than the total number of parents plus their unmarried classmates?

Many of the children of the earlier graduates are doubtless middle-aged by this time, but on the other hand a considerable number of the offspring of the later graduates are probably still young children. Therefore, direct observations on these children would not furnish a satisfactory answer to this question.

The nearest approach to an accurate answer is found by employing a mortality table. In such a table a hypothetical number of individuals (10,000 or 100,000 for instance) is represented as starting life, say at 0 age. The probable number that will survive death is then shown for each succeeding year until extreme old age. I have employed the Northeastern States Mortality Table.[17] The data used in constructing this table were "the death returns for the five calendar years 1908-1912, inclusive, and the census returns as of June 1, 1900, and April 15, 1910, for the New England States and the three Middle Atlantic States, New York, New Jersey, and Pennsylvania." It will be observed that this table is a recent one covering the territory in which a very large part of the graduates have lived.

The numerical maintenance of this limited section of the population obviously depends not only upon the replacement of the parents (one or both of whom in each family is a graduate of Allegheny College), but also of the unmarried classmates of the parents. A few of the men (14) married women graduates. These women are counted among the wives of the male graduates and not under the heading of women graduates in Tables 8 and 10. Thus they are not counted twice. Whenever a male alumnus married a second time, the second wife is, of course, counted as one of the parental group.

The children indicated in Table 8 are from only those families where the total number of children to date (living and dead) was given on the questionnaires.

The number of children computed to be the survivors at 23 years, the approximate average age at which their parents graduated (Table 3), is fifty-nine less than the parental group. This number of survivors at twenty-three years is only ninety-one per cent. of the parental group.

Compare this with the record of the ministerial graduates, Table 9.

The ministerial group, with its relatively high marriage and birth rates, is apparently increasing, for the computed number of children surviving at age of twenty-three years is thirty-six per cent. *in excess* of the parental group. The birth rates in Table 7 should be consulted in connection with Table 9. There is no apparent reason for believing that the clergymen as a group have been naturally more fertile than the other alumni. Conscientious scruples, entirely praiseworthy in the main, may have prevented them from using contraceptive measures to the same extent as the other graduates. It should be noted, however, that the size of the family shows an abrupt decrease in the second period.

I suspect that a real process of natural selection has been operating here. The minister, more altruistic and with greater faith in the future than his schoolmates, has ventured to rear more children, even on an inadequate salary. The writer is not aware that love of children, altruism, or any other characteristics that would lead to the desire for a large family, are inherited; but if they are inheritable the greater reproductive rate of the ministers may be eugenically significant. Surely, it would be fortunate if the higher moral qualities could be disseminated in a race by the extinction of selfish strains through excessive birth control, and a corresponding increase in altruists.

Some of the families represented in Table 8 will doubtless be augmented. A part of the women there have not reached the end of the reproductive period. The families in Table 10 are complete, as far as can be determined. The families of male graduates are confined to those in which (1) the husband is dead, or (2) both husband and wife are living, but the wife is not divorced and is 45 years old or older. Obviously a widower or divorced man could marry a woman young enough to bear children. The number of unmarried men has been reduced so that the ratio between married and unmarried is the same as in Table 8; the same is true for the women.

The number of offspring computed as survivors at the age of twenty-three is, curiously, ninety-one per cent. of the parental group here also.

This percentage is probably too low, for the following reasons. These children came from parents who were longer-lived, on the average, than the complete body of graduates from 1870-1899. The rather unusual vigor of the parents, manifesting itself as corresponding extension of life, has doubtless been transmitted to some extent to their children. Therefore it may be that these children have the capacity for living longer, on the average, than even the population from which the Northeastern States Mortality Table was computed. But it is hard to believe that the survivors at the age of twenty-three years would much exceed the parental group numerically. The total number of children at birth was only seventeen or eighteen per cent (Tables 8 and 10) in excess of the parent group. The great mortality of infancy (nearly thirteen per cent. during the first year of life, ordinarily) would surely greatly reduce this excess.

A study of the reporting graduates of the classes from 1890-1899 furnishes confirmatory, though by itself inconclusive, evidence in favor of the view that the group of graduates

about whom we have gathered complete information has hardly more than replaced itself. There were 126 men in this decade whose total number of children to date, living and dead, were reported. There were nineteen single men. The married men had been married an average of 22.7 years when the information was collected. This parental group of 271 persons (husbands, wives, and single men) had 279 surviving children. The latter exceeded the former by three per cent. The average age of the children is not known, but it is probably considerably less than the above average duration of the married period. That is, the mean age of the children is doubtless less than twenty-three years. The slight excess (3 per cent.) in the number of children above the parental group will undoubtedly be lowered or obliterated by the time the average age reaches twenty-three years.

If only those families (70 in number) are considered in which future child bearing is improbable or impossible, the surviving children (161) exceed the parental group (husbands, wives, and a proportionate number of single men) by only 6.6 per cent. The average duration of married life in these cases was 25.3 years.

The ages of the fifteen women graduates of the decade 1890-1899 show that their families will doubtless not increase. All but one (43 years old) have reached or passed their forty-fifth year. There are only twenty-two surviving children, scarcely half the number (45) of the parental group (husbands, wives, and single women).

Conclusion

I believe the facts justify the following conclusions. (1) The *selected group* of graduates I have studied will raise to maturity only about enough children to replace itself. (2) Could complete data have been collected for *all* the graduates from 1870-1899, it would probably have been found that this aggregation has not replaced itself. It will be recalled that about twenty-five per cent of the alumni are dead. This means that the survivors, to whose families almost exclusively our facts apply, were longer-lived, on the whole, than their deceased colleagues. The longer-lived people have the larger families. Hence the group of alumni we have studied was doubtless somewhat more fecund, in proportion to its size, than the whole alumni body. Therefore, if the former scarcely more than replaced itself, the latter probably did not.*

The writer does not imply that Allegheny College is in any way unique in this respect. Low birth rates seem to be characteristic, as has been mentioned, of college graduates and the "higher" classes of society in general. The showing of the Allegheny College alumni is better than that of graduates of Wellesley, Mount Holyoke, Vassar, Harvard, Yale, and Syracuse. The writer is inclined to believe that the pleasant and wholesome social relationships, fostered by the college authorities, between men and women students at Allegheny, favors matrimony.

*The following suggestion was received from Dr. Sewall Wright of Washington, D. C., after this article went to press:

It is obvious that the parental group under consideration includes not only the college graduates, but also a part of the general population, namely, the wives and husbands of these graduates. Hence, in addition to including in the parental group the unmarried graduates, a certain number of unmarried persons from that section of the population into which the graduates married should have been added to the parental group. The writer knows of no way in which the appropriate number of such single persons from the general population could be computed. However, it is clear for the above reason that the parental group cited in this paper is smaller than it should be. Therefore, it seems likely that the families of Allegheny graduates have fallen even farther short of replacing their section of the population than is indicated in this article.

The situation, from a biological and racial standpoint, at Allegheny College and the other institutions cited, is unsatisfactory. The population of the United States has more than doubled during the period covered by this study. Much of this increase is due to the immigration of stocks of doubtful or inferior worth. The spectacle of the stationary or dwindling old American families of demonstrated capacity, silhouetted against the (until recently) inrushing hordes from southern and eastern Europe, is an ominous spectacle that no intelligent person will ignore.

The ethical aspects of the problem should be considered with the biological. Childless persons and single children are not likely to be habitually cooperative. The "give and take" in a family of five or six persons develops habits of helpfulness that make a better neighbor and citizen. Love of the members of one's family is a channel through which love for mankind in general may easily flow.

Summary

Variations in mental capacity are inherited. In spite of the fact that civilization and progress depend upon a sufficient proportion of unusually intelligent persons, such strains do not appear to be holding their own in our increasing population. This is true of college graduates as far as they have been studied. The birth and marriage rates have remained fairly constant for graduates of Allegheny College (classes of 1870-1899), but the group has probably fallen somewhat short of producing enough children to replace itself.

TABLE 7. *Data concerning families of clergymen.*

Period of graduation	Single		Married		Average age at graduation	Average age at marriage	Childless Marriages		Av. No. children per family
	No.	Per cent	No.	Per cent			No.	Per cent	
1870-1884	1	4.3	22	95.7	24.9	29.5	2	9.1	4.7
1885-1899	1	2.6	37	97.4	26.2	30.8	6	16.2	3.0

TABLE 8. *Comparison of parental group with the computed number of children to reach an age of 20-24 years.*

Number of married man graduates, plus their wives, some of whom are graduates	510
Number of second wives of men graduates	9
Number of single men graduates	36
Number of married women graduates, plus their husbands; women who married men graduates are omitted	54
Number of single women graduates	32
Parental group, total	641
Number of men graduates' children, living and dead; (includes all children both of whose parents are graduates)	698
Number of women graduates' children, living and dead	54
Total children	752
Computed surviving children, age 20 years	591
Computed surviving children, age 21 years	588
Computed surviving children, age 22 years	585
Computed surviving children, age 23 years	582
Computed surviving children, age 24 years	579

TABLE 9. *Comparison of clergymen of parental group with the number of their surviving children 23 years of age.*

Number of married ministerial graduates plus their wives	118
Number of second wives	3
Number of single ministerial graduates	2
Total	123
Number of minister's children, living and dead	216
Computed surviving children, age 23	167

TABLE 10. *Comparison of size of parental group in which the wives are at least 45 years of age, with the number of surviving children 20-24 years old.*

Number of married men graduates, plus their wives, some of whom are graduates	352
Number of second wives of men graduates	7
Number of single men graduates	25
Number of married women graduates (45 years old or older, or deceased), plus their husbands; women who married men graduates are omitted	48
Number of single women graduates	28
Parental group, total	460
Number of men graduates' children, living and dead, (includes all children, both of whose parents were graduates)	493
Number of women graduates' children, living and dead	49
Total children	542
Computed surviving children, age 20 years	426
Computed surviving children, age 21 years	424
Computed surviving children, age 22 years	422
Computed surviving children, age 23 years	420
Computed surviving children, age 24 years	418

A Handbook for Tropical Plant Breeders

HANDBUCH DER LANDWIRTHSCHAFTLICHE PFLANZENZUECHTUNG, by C. FRUWIRTH. Band V., Die Zeuchtung kolonialer Gewaechse. Zweite, gaenzlich neubearbeitete Auflage. Pp. 272. Price, $2.00. Berlin, Verlagsbuchhandlung Paul Parey, 1923.

The first edition (1912) of Dr. Fruwirth's unique and almost indispensible work has been out of print for nine years; only the war and the subsequent difficulty of getting together a new set of collaborators have caused this delay in its reappearance. The present book is rewritten and brought up to date by experts from all parts of the world: American collaborators are H. J. Webber (citrus fruits), O. E. White (castor bean), and G. F. Freeman (cotton). While most of the important colonial products are given attention, one notes some strange omissions, as for instance, the banana and the pineapple. The date palm is dismissed with a perfunctory single page. The volume lacks an index. But despite some imperfections, the book stands alone as a compilation of the most useful data on the breeding of some of the principal crops of the world. Much of the most important work in plant breeding during the next few generations is likely to be done in the hitherto largely untouched field of tropical crops, and Dr. Fruwirth's handbook will probably be the starting point for most of the breeders.—*P. P.*

The

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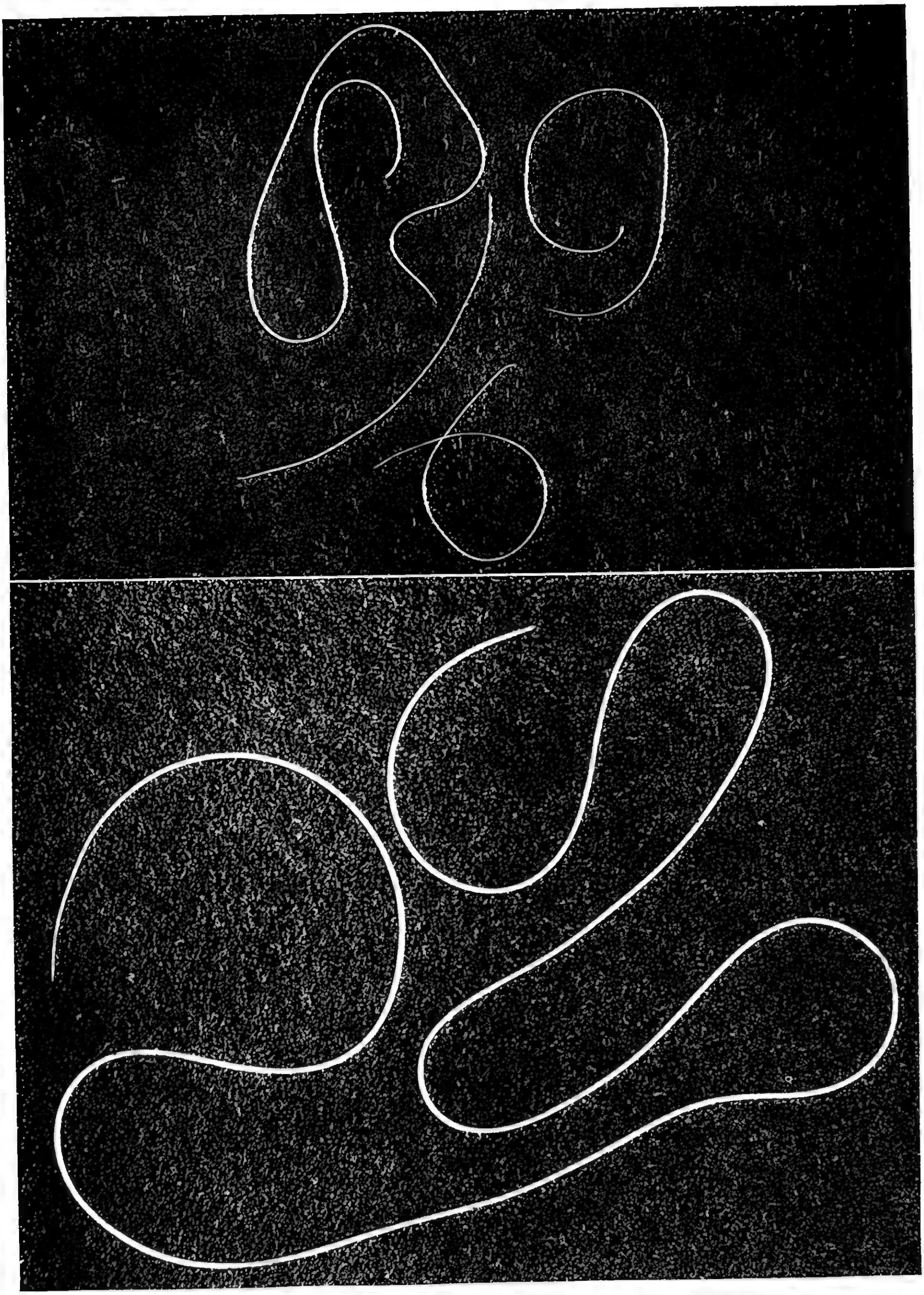


MALE AND FEMALE HAIRWORMS

The genus Agameris contains some of the larger species of hairworms. The average length of the females of *Ag. decaudata* (bottom) is nearly eleven inches; that of the males (top) is not quite three inches. Many nematodes are parasites, and nearly every kind of plant and animal is an actual or potential host for one or more species of them. Nematodes are not immune from attacks by their own kind; in some cases they even prey on individuals of the same species, something very unusual among anything but human parasites. Their parasitic habit gives nematodes great economic importance. Some species are a serious menace to crops and herds, while others prey on our most dangerous insect pests and offer a promising means of combating them.

INTERSEXES IN NEMATODES

G. Steiner

Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

STIMULATED by the experiments of Goldschmidt on the Gypsy Moth the writer carried out extensive experiments in the winter and spring of 1921-22, in which he attempted to cross several morphologically closely related free-living nematode species.[1] The chief aim was to see if intersexes (as the term is used by Goldschmidt) could be produced by hybridization of certain easily reared species.

Intersexes are individuals which possess the sexual characters of one sex mixed with the characters of the other. Such cases have been long known and some of them were designated hermaphrodites, gynandromorphes, etc. Modern experiments have showed that whole series occur in which the characters of a male and female are more or less mixed, thus representing all possible steps between a true female and a true male.

Mention of some intersexes already existed in nematode literature; there were several short accounts of them in some species of *Mermithidae*, and a description of those reported in other genera is given in later paragraphs of this paper.

Unfortunately my experiments did not have the desired results. It seems to be very difficult to cross the species of the genera mentioned in the foot note. Thus far my experience agrees with that of Maupas, published in a posthumus paper edited by Caullery.[2]

During the last few months the writer was called upon to identify a large number of Mermithidae. Numerous intersexes were observed. Since the sex problem is today a center of biological discussion, a description of these intersexes is certainly of some interest at this time.

Intersexes in the Hair-Worm

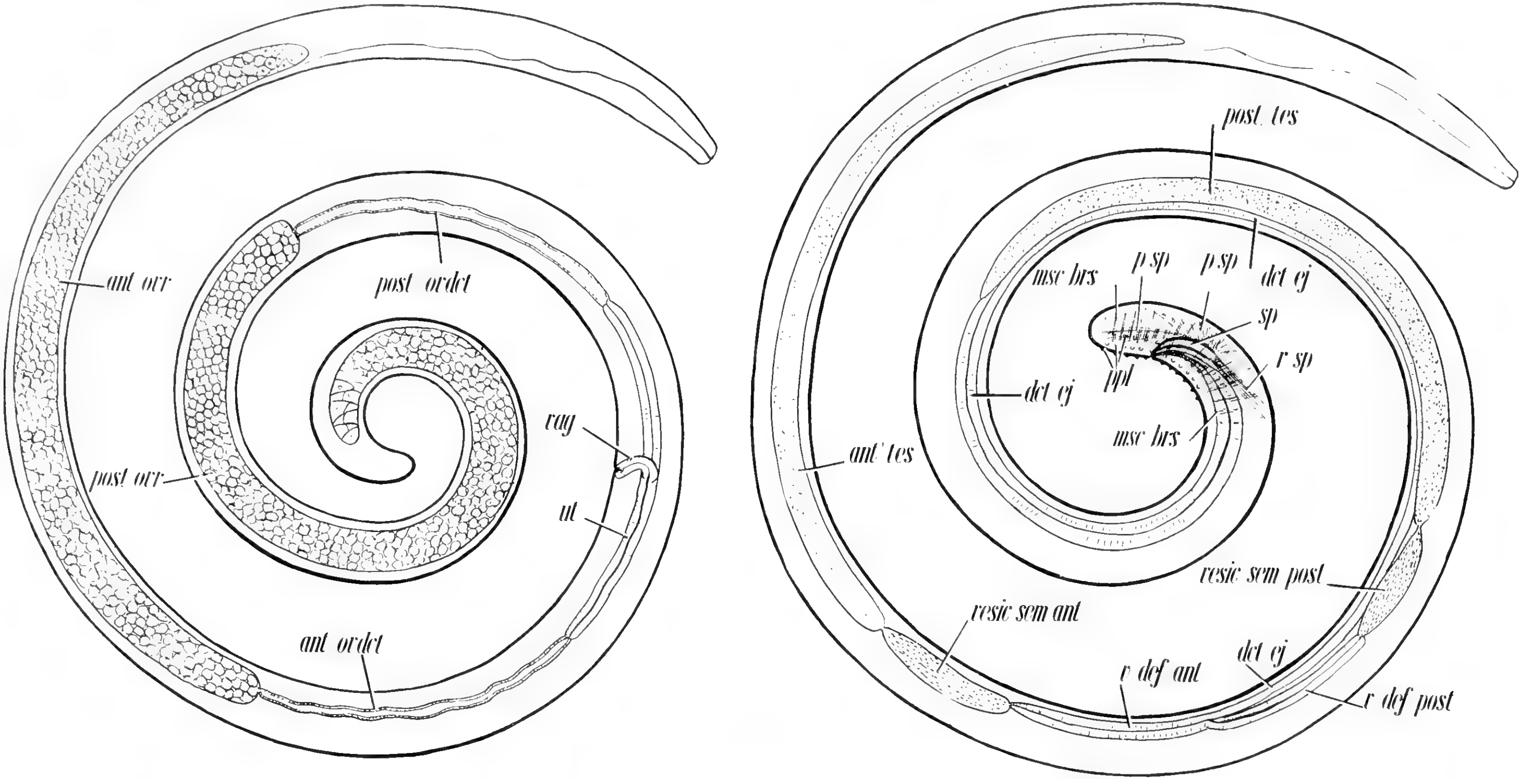
Hitherto every investigator who has studied any considerable number of *Ag. albicans*[3] or related forms, mentions the presence of intersexes[4] in this species. Meissner in his splendid study of this form describes as early

[1] For the opportunity to carry on these experiments I am greatly indebted to the authorities of Yale University and the staff of the Osborn Zoological Laboratory, New Haven, Conn. Species of Rhabditis, Plectus, Cephalobus and Diplogaster were used in these experiments, an account of which will be given in a later paper.

[2] Maupas, Emile, Essay d'Hybridation chez des Nematodes. Bull. Biol. de la France et de la Belgique. T. 52. 1919.

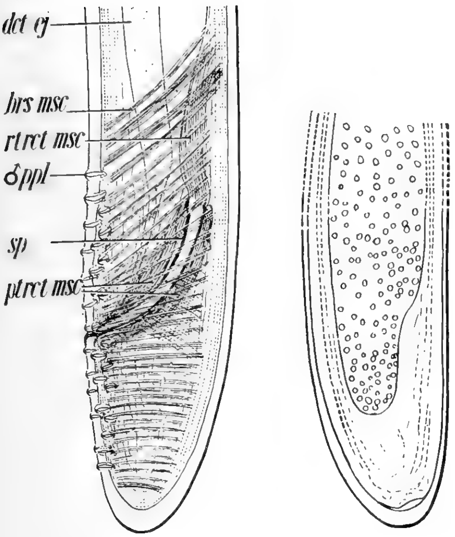
[3] During recent experiments it was found best to split the former genus Mermis into several new genera. In the future the genus Mermis will include only those forms with four head papillae, two mouth papillae, amphids situated laterally in the same level with the head papillae, mouth terminal, vagina S-shaped; type species *M. nigrescens Duj.* The new genus Agamermis will include forms with six head papillae, no mouth papillae, amphids mostly behind the lateral head papillae, or slightly shifted dorsad, mouth terminal, vagina S-shaped. In entering the host the preparasitic larva of this genus drops five-sixths of its body through self-amputation at a preformed node. Our type species, *Ag. decaudata* resembles very much the former *Mermis albicans* as described by Meissner and partly by Hagmeier, but differs from it through the structure and position of the amphids or lateral organs, and the cells around the esophagus. Furthermore it is not known whether in the latter form the tailpart of the larval body is dropped by self-amputation, as in *Ag. decaudata.* We are sure that *M. albicans* of earlier investigators includes perhaps a number of different species. For further details, see the preliminary paper: Cobb, Steiner, and Christie, *Agamermis decaudata*, a Nema Parasite of Grasshoppers and Other Insects. *Journal of Agricultural Research,* Vol. 23, No. 11, 1923.

[4] They were not termed such, but were called hermaphrodites or "Zwitter."



INTERNAL STRUCTURE OF MALE AND FEMALE HAIRWORMS

FIGURE 1. These outline drawings are not strictly to scale and only the reproductive organs are shown, these being the parts of most interest in connection with this article. The nematodes are such slender animals that paired organs would have no space to lie side by side, and so are arranged "tandem." The nematodes offer a unique field for the experimental study of many biological problems. Under the microscope the physiologist can actually observe many metabolic processes that he can study only indirectly in larger organisms. More variations in reproductive processes and in the sex ratio are found in nematodes than in any other animals. Species are known in which no males or only one male is produced to five hundred females, and others in which ten times more males occur than females, and between these extremes are species in which any intermediate ratio can be found. *ant. ovr,* anterior ovary; *ant ovdct,* anterior oviduct; *post ovr,* posterior ovary; *post ovdct,* posterior oviduct; *ut,* uterus; *vag,* vagina; *ant test,* anterior testis; *dct cj,* ductus ejaculatorius; *msc brs,* bursal muscles; *ppl,* male copulatory papillae; *p sp,* protractor muscles of the spicula; *r sp,* retractor muscles of the spicula; *sp,* spiculum; *v def ant,* anterior vas deferens; *v def post,* posterior vas deferens; *vesic sem ant,* anterior seminal vesicle; *vesic sem post,* posterior seminal vesicle.



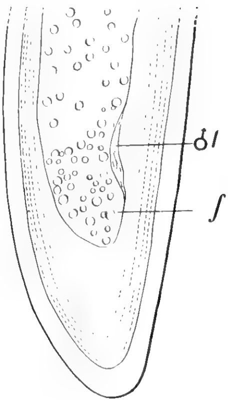
TAIL END OF MALE AND FEMALE NEMATODES

FIGURE 2. Intersexes are individuals having the reproductive organs of one sex and, in addition, certain organs or tissues typical of the other. All of the intersexes so far observed in nematodes have been females in which certain typically male parts are present. Above is shown the tail end of a normal female (right) and of a normal male (left), showing the male organs that are found in intersexual females (Figures 5-8). *dct ej*, ejaculatory duct; *brs musc*, bursal muscle; *♂ ppl*, male papilla; *ptrct msc.*, protractor muscle; *rtrct msc*, retractor muscle; *sp, spiculum.*

as 1854 three intersexual females and is very much puzzled over this unusual combination of male and female characters.

The majority of the specimens of *Agamermis decaudata* which I have had the opportunity to study came from Falls Church, Virginia, and were collected by Mr. J. R. Christie. It was very striking that the specimens with intersexual characters were as numerous as, or even more numerous than, normal females.

One important fact, to be noted at the outset, is that *hitherto only intersexual females have been observed,*—that is, all specimens with intersexual characters were females; the female



A SLIGHTLY INTERSEXUAL FORM

FIGURE 3. Tail end of female *Ag. decaudata,* showing a small amount of male tissue (♂ t). Goldschmidt experimentally produced "consecutive intersexuality" in moths by crossing related races. These individuals would begin life as females and gradually change to males, at the same time losing their female characters. He accounted for this change by assuming that the sex determiners of the different races used in the experiment had a different relative rate of activity, and that an initially slow-working "male factor" would gradually increase in activity until it overshadowed the "female factor," when the individual would change from a female to a male.

sex organs were completely and normally developed. Vulva, vagina, uteri and ovaries were normal and in most of the animals eggs were present in the oviducts and uteri. Up to the present the writer has never seen a male with intersexual characters, and, as far as he knows, no other investigator has.

Let us now first see what a normal female and male of this species look like:

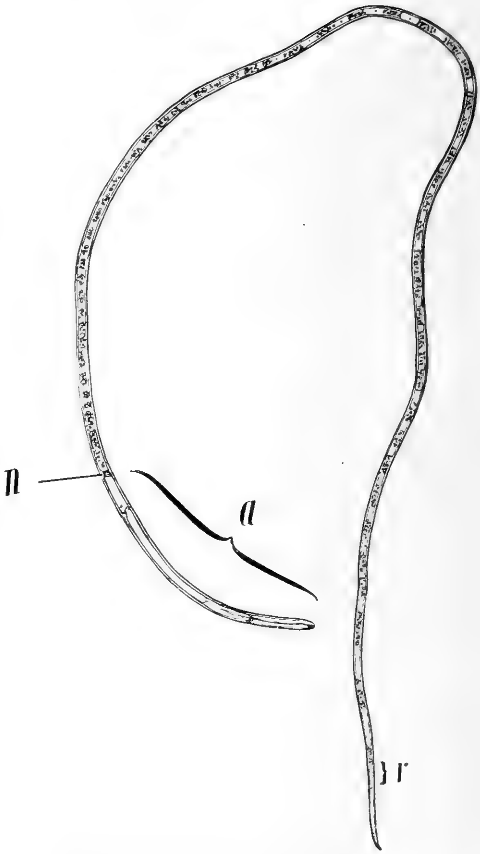
The two sexes may be distinguished from each other with the naked eye, as they are in most cases distinctly different in size. The photographs, (Frontispiece), show a female and several males that were found together in the soil. The female is several times larger than the male. The average length of six females was found to be 293.7 mm., ranging from 190 to 380 mm., whereas the average length of ten males was only 63.5 mm., rang-

ing from 42 to 104 mm. Hagmeier gives for the males of *Ag. albicans* a length from 29 to 80 mm., for the females 38 to 320 mm. Occasionally very small females may also be seen in this species exceeding in length only slightly, or not at all, the average male. Unusually large males have also been observed, attaining the length of the smaller females. While the size may therefore have a certain value in determining the sex of individuals the gonads and copulatory organs are nevertheless the chief characters. The female sexual opening, the vulva, is a narrow transverse fissure near the middle of the body. It leads into a tubular vagina opening at right angles into the uteri. They are outstretched, one forward the other backward, and merging through the oviducts into the ovaries (Fig. 1).

The male sex opening, however, is situated near the tail end, and combined with a copulatory apparatus consisting of two cutinized spicula and the muscles needed to move them. The *ductus ejaculatorius*, succeeded by the *vas deferens*, leads to two testes of which the one is outstretched forward and the other backward. Furthermore, so-called bursal muscles are present in the tail end of the male on each side a left hand and a right hand series. They are slightly inclined to the body axis and by their action the tail end of the male is enabled to embrace in a spiral manner the body of the female. Besides these organs there are numerous papillae on the male tail end, being the endings of nerve fibres, as shown in Figures 1 and 2.

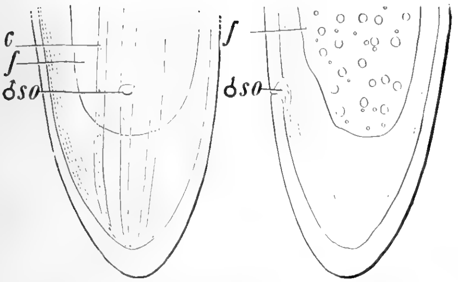
Thus the organization of the female *Ag. decaudata*, is distinctly different from that of the male. Hagmeier observed another difference between males and females of *Ag. albicans*, namely, the size of the amphids (Cobb) or lateral organs, which he says are smaller in the female than in the male. In our specimens we were not able to observe this distinction.

The intersexes observed in American *Ag. decaudata* and now about to be described, are, as already mentioned, all females. They all have complete normal female sex organs and most of them normal eggs in the uteri, and all were found encoiled and copulating



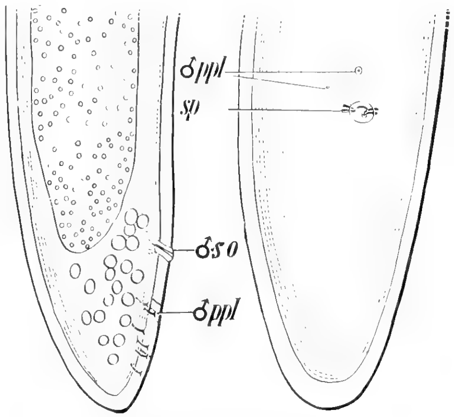
FREE-LIVING LARVAL FORM

FIGURE 4. The first larval stage of *Ag. decaudata* is free-living, while the second larval stage is parasitic upon grasshoppers, roaches and possibly other insects. When the larva enters the host or shortly afterward about five-sixths of the body is dropped and only the head end (*a*, in figure) continues to live and grows into the adult. Division of the body takes place at a preformed node (*n*). This is one of the most remarkable cases of self-amputation known and was first observed by Dr. N. A. Cobb. It shows that the part of the alimentary tract that is homologous with the rectal and anal regions of other nematodes (*r*, in figure), is dropped in this species. Therefore what openings occur at the tail-end of the adults can only be regarded as sex openings and never as anal openings.



TAIL OF INTERSEXUAL FEMALE

FIGURE 5. Two views of the tail of female *Ag. decaudata,* having a male sex opening (♂ *so*). In the normal female no such openings occurs, and this cannot be considered a rudimentary anal opening because that region has been lost in the adult form (see Figure 4). It is difficult to arrange intersexual characters in a very definite graded series because in some cases one male organ will be highly developed and in other individuals this organ will be rudimentary and others will be much more prominent. *c,* sub-median longitudinal chord; *f,* fat body; ♂ *so.,* male sex opening.



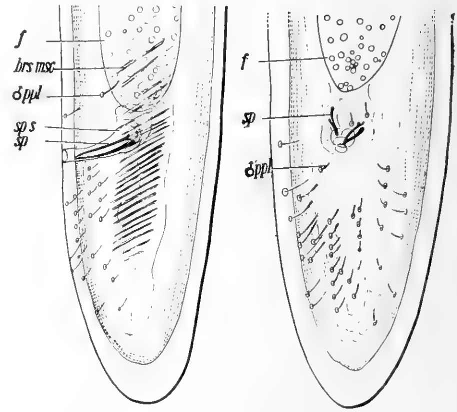
MALE CHARACTERS MORE HIGHLY DEVELOPED

FIGURE 6. Tail ends of two females showing more marked intersexuality. The individual on the left has a male sex opening (♂ *so*) and male papillae (♂ *ppl*). The one on the right has two rudimentary spicula (*sp*), and male papillae much less developed than the other specimen. Irregularity in the development of the male organs is characteristic in these intersexes. It is believed that this is due to the fact that these forms are produced by hybridization of different races, in which the time and rate of differentiation of the sex organs vary considerably.

with males. The intersexual state is only to be determined by examination of the tail end. This tail end has more or less the structure and organization of the tail end of a male. We have pictured such transformed female tail ends in Figures 4 to 8. All grades of transformation can be seen from the typical female to a typical male tail end (Figure 2).

Figure 4 is the tail end of a female which shows only a small amount of tissue (connected with the fat body) which has to be regarded as tissue of a male character, since in the normal female no such structure exists.

A more pronounced intersexuality is developed in the female whose tail end is sketched in Figure 5. Here a rudimentary male sex opening is present. It may be said that this structure should be compared with an anal opening and be designated as such. The ancestors of Agamermis certainly once had a complete alimentary tract, and therefore also a functional anal opening. The figured rudimentary openings could be said to be a rudimentary anal opening, homologous with the anal openings of other female nemas, but the ontogenetical development of our forms precludes such a possibility. As Cobb first observed, and as described in the above-mentioned preliminary paper[3], the young larva of *Ag. decaudata* in entering the host loses about five-sixths of its total body length by self-amputation. What develops into the adult *Ag. decaudata* is only the small head part of the preparasitic larva, shown in Figure 4. At a point about one-sixth of the larva's total length from its head end a small series of coin-like cells develops, forming a distinct node. In entering the host the larva drops all of its body posterior to this node by breaking in two at this point. Sometimes the posterior part of the larval body does not enter the host at all, breaking off as soon as the head of the larva has worked its way into the host. In other cases the whole larva enters the host



WELL-DEVELOPED SPICULA

FIGURE 7. Two views of a female with well developed spicula (*sp*), bursal muscles (*bur musc*) and papillae (♂ *ppl.*). It must be borne in mind that all the individuals shown in these illustrations have in addition to the male organs a complete and functional set of female organs. Left, lateral view; right, medio-dorsal view; *sp s*, spiculum sheath.

and the act of self-amputation takes place later.

It follows from these facts that the above-mentioned openings of the female tail end of *Ag. decaudata* and perhaps of other female Mermithids can not be regarded as rudimentary anal openings, but must be sex openings, as all tissues which are homologous with the posterior intestine, the rectum, and the anus of the majority of adult nematodes are dropped by the Agamermis larva when the act of self-amputation takes place.

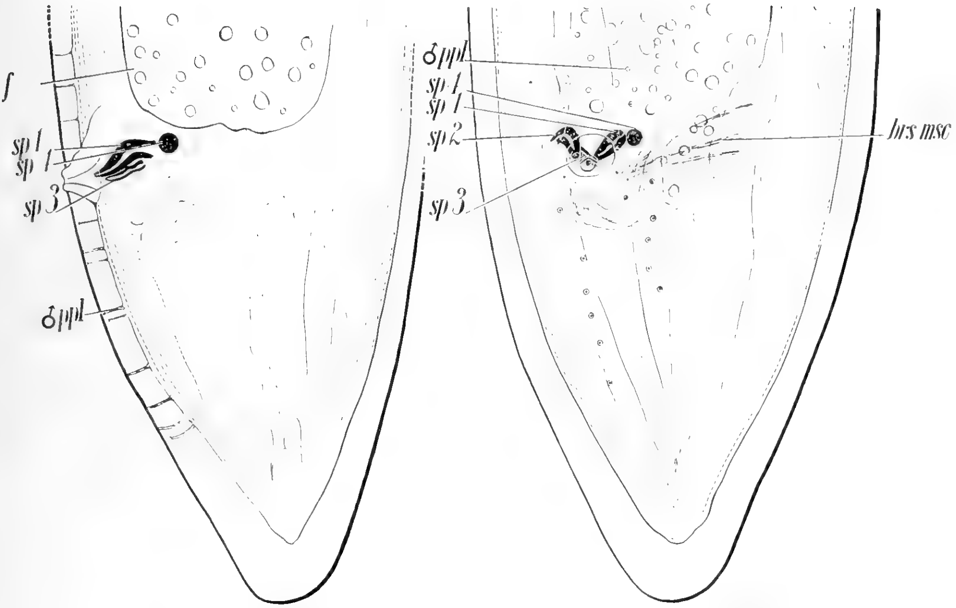
Furthermore the relative frequency of these openings, and the fact that such female tail ends form a graded series linking the normal female and the normal male tail end, speaks against the conception that they are anal openings. If we take this grade of transformation out of the series, the other members of it could not be understood or placed, whereas by regarding it as a reduced male sex opening, it completes a natural structural series that can be understood without difficulty. Hagmeier too regards these openings as rudimentary male sex openings and not as vestiges of an anal opening.

Figure 6 is a sketch of two female tail ends, one of which has not only the male sexual opening, but also a number of male papillae. The other represents a further step to more pronounced intersexuality. There is a rudimentary male sex opening, and also two very small spicula and traces of two male papillae.

Much more pronounced is the intersexuality of the female of which the tail end is pictured in Figure 7. The first gives a lateral, the second a ventro-medial view. A distinct sex opening is present as well as spicula, which are asymmetric; the spiculum of the left side consists of two separated pieces. Some tissue belonging probably to the sheaths of the spicula is also developed. Numerous bursal muscles and male papillae are also present, the latter not fully grown.

The tail end of an intersexual female sketched in Figure 8 is of particular interest, having four pieces of spicula; morever, they are asymmetric left to right; those at the left have the general form of spicula, the one being smaller than the other. At the right, there is, besides a somewhat normal-shaped but small spiculum, a globular body. Tissue has developed around the spicula, also a sex opening can be observed as well as some few bursal muscles. Male papillae of more rudimentary character are also present.

Three more advanced cases of intersexuality were mentioned and described by Meissner in *Ag. albicans.* I myself have not yet seen such high grade intersexes. In these three specimens of Meissner even the size seems to have been involved in the transmutation toward the male. He states that all three of these females were dwarfs, compared with normal females, and had only the length of males. It accords with this that the other male characters also were more developed than in the specimens above described. Meissner says that the tail ends of his females were completely masculine, with two normally formed spicula of



TWO VIEWS OF A HIGHLY INTERSEXUAL FEMALE

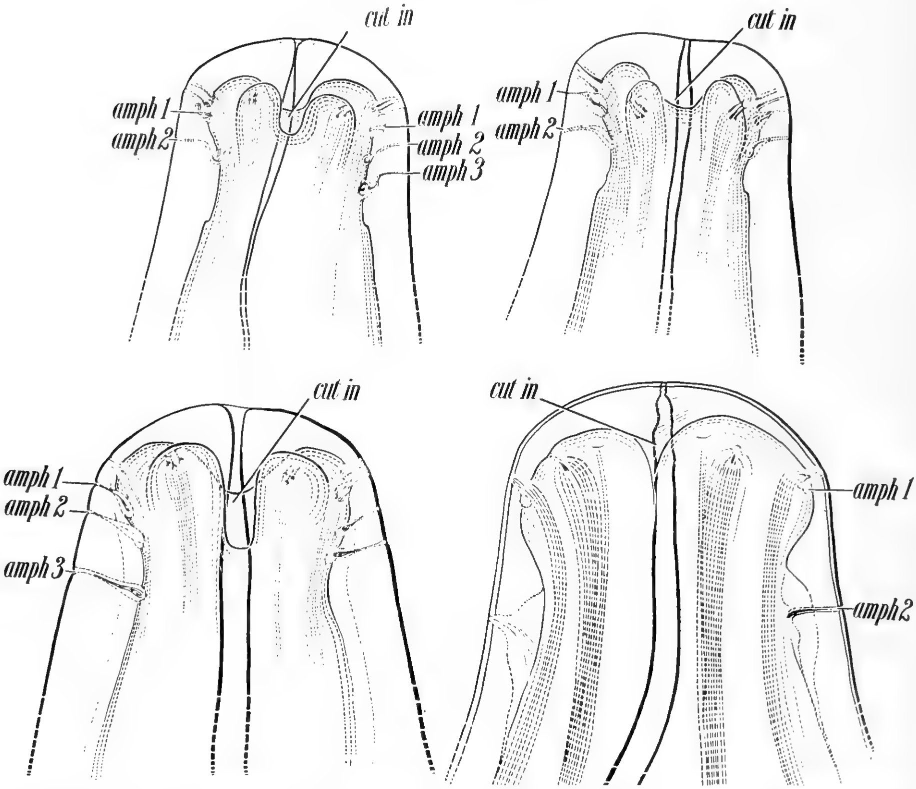
FIGURE 8. This female has a double set of male spicula (*sp* 1-4). Three are normal in shape, and the fourth is represented by a spherical body. Notice that there are much fewer papillae than in the female shown in Figure 7. These intersexes are probably due to natural crossing of distinct races or closely related species, as were the intersexes of the gypsy moth produced artificially by Goldschmidt. Left, lateral view; right, ventra-submedial view; *f*, fat body; ♂ *ppl*, male papilla; *sp* 1, spiculum of the left side; *sp* 3, second spiculum of the right side; *sp* 4, globular second spiculum of the left side; *burs musc*, bursal muscle.

equal length and thickness with the sheaths well developed, but the muscles around the spicula were not as strong as in the true male. However, the bursal muscles, the rows of male papillae, and even the general form of the tail end was exactly like the normal male. But there was no trace of male gonads and ducts. Very interesting it seems to me is Meissner's statement that in the intersexual females the eggs were, though normal, somewhat smaller.

Undoubtedly these intersexes are the most pronounced of this kind hitherto observed in Mermithids. They allow us to construct a complete series of intersexual females with all possible grades between a normal female and a female with complete male secondary sex characters.

As already stated, nearly every investigator who has studied carefully adequate material of *Ag. albicans* has observed such intersexes. Intersexuality seems in this species of *Agamermis* to be a rather common phenomenon. *As far as we know there is no other group of animals known today in which intersexes are observed in such numbers under natural conditions and normally produced.* This seems to be a fact specially to be noted.

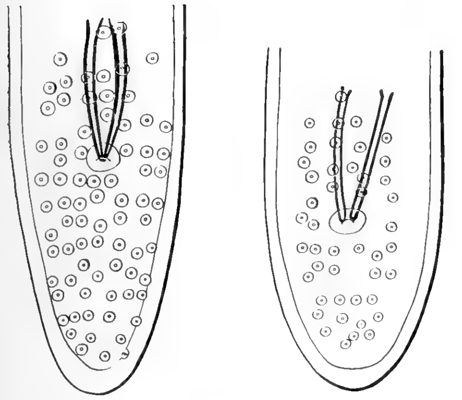
What are the causes of these conditions? As yet we do not know, but there are some other facts about *Agamermis decaudata* and related forms which may indicate where we must look for an explanation. Recently intersexes have been produced experimentally by several investigators, as by Goldschmidt in *Lymantria dispar;* by Keilin and Nuttal in *Pediculus capitis* and *P. corporis;* by Sexton and Huxley in *Gammarus chevreuxi* and related



VARIATIONS IN HEAD ORGANS IN SPECIES PRODUCING INTERSEXES

FIGURE 9. The head organs of most species of nematodes are very constant in form and position. The function of the amphids (*Amph* 1-3) is not definitely known, but there is reason to believe that they are chemical sense organs. The fact that they are so similar on different individuals of the same species makes them of great value in the systematic classification of nematodes. In the case of *Ag. decaudata*, however, we find a striking exception to this rule, for great variation is observed in the number and position of the amphids. This is further evidence of the existence of numerous closely related species which intercross in nature. *Amph*, amphid; *cut in*, cuticular incision between the papillae of the left and the right side.

forms, by Bridges in mutants of *Drosophila melanogaster* and by Sturtevant in *Drosophila simulans*. In all these cases intersexes resulted from hybridization of closely related genotypes. Are there signs that also in our case the observed intersexes could be the result of hybridization of races or genotypes closely related and living mixed with each other in nature? This appears to be the fact. Many difficulties arose as I tried to identify the material brought to me. In the taxonomy of nematodes the structure of the head end and chiefly the organization, the location and number of the head sense-organs are of high importance. This is particularly true in the Mermithids, where other characters for the distinction of the species are very few in number and many of them to be seen with great difficulty or only on adult specimens. Therefore, a close study of the head end and its sense-organs is absolutely needed for a good identification. There are two kinds of head sense-organs in most of the nematodes—the *papillae*, which are claimed to be organs of touch, and the *amphids* (Cobb) or *lateral organs*, which are



TAIL ENDS OF NORMAL MALES

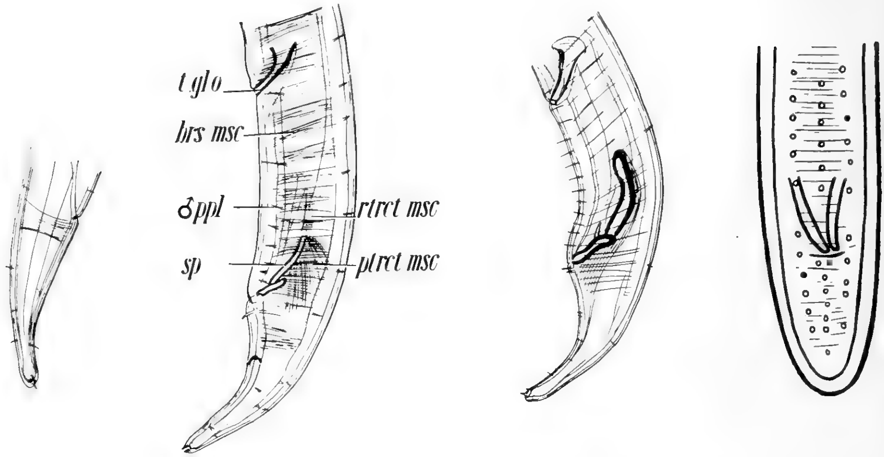
FIGURE 10. In addition to the variation in the head organs of this species, other normally constant characters are unusually variable. This shows the tail ends of two normal males of *Ag. decaudata.* Note the considerable variation in the position and number of the papillae. These differences are greater than are found in other species of nematodes.

probably chemical sense organs. These organs are of very constant nature in nearly all nematode species, and the amphids, or lateral organs are especially of high value as specific characters. In the Mermithidae this is particularly true. The adult specimens may be identified more or less easily by the aid of the sex organs, but the larval specimens can only or best be distinguished by the sense organs of the head. The position, the size, and the structure of the amphids is very different in different species of Mermithidae, although within the species, with few exceptions, very constant. Such exceptions are *Ag. decaudata* and related forms. The number, the structure and the position of the amphids varies here very much, but other significant and easily perceptible differences have not yet been discovered. There are differences also in the shape of the tail end, but these are insignificant. Perhaps the number of metabolic cells along the esophageal tube may be of taxonomic use if more were known about them.

Figure 9 shows the head ends of specimens of *Ag. decaudata,* all differing from each other in respect to the amphids. Why in this form are the amphids so inconstant, while they are so constant in most of the other nematodes? Is it not that we have in *Ag. decaudata* and related forms, not sharp-cut species, but an association of different races or genotypes and numbers of hybrids between them? These races are perhaps continually crossing and it is thus that such a multitude of structural forms in the head end comes about. The numerous intersexes are another result of these crossings between closely related genotypes. In the light of the experiments of Goldschmidt and the other above-mentioned investigators, where intersexes resulted from hybridization of closely related forms, it is highly probable that there is a causative relationship in this case between the numerous related species and races, and the number of intersexes observed. Yet this is only an explanation which seems to give most satisfaction, and could not be accepted as final until the matter has been tested by experiment.

More recent experiments point to the same conclusion. What was formerly called *Mermis albicans* by different authors is perhaps a group of morphologically closely related forms. It may be that they are species, or at least races. One of these may perhaps be our *Agamermis decaudata,* which in the adult stage resembles to a high degree the former species and was apparently taken as such by Leidy and other authors. Experiments by T. R. Christie and the writer show that the larvae of this latter species (decaudata), could not be brought to infest other animals than grasshoppers and roaches. Yet this form very much resembles the former, which is said by many writers to parasitize insects of the most various groups, and even snails.

All these facts, it seems, are good evidence that the numerous intersexes observed as normally forthcoming in



INTERSEXES FOUND IN OTHER GROUPS

FIGURE 11. Intersexes have also been observed in several other groups of nematodes. The three left hand figures show respectively the tails of a normal female, a highly intersexual female, and of a normal male of *Enoplus michealsoni* v. List. (After de Man). This form is a free living marine nematode, very different from the species discussed in this paper. On the right is shown the tail of a highly intersexual female of *Mermis mirabilis,* as described and figured by von Linstow. The male copulatory organs of this female were well developed. *burs musc,* bursal muscle; *♂ ppl,* male papilla of bristle shape; *ptrct mus,* protractor muscle of the spiculum; *rtrct msc,* retractor muscle; *t gl o,* tubular gland outlet, typical of the male; *sp,* spiculum.

our Mermithids are a result of hybridization.

Intersexes in Other Mermithid Species

Ag. decaudata and *Ag. albicans* are far from being the only Mermithid species where intersexes have been observed.

v. Linstow mentions (1903) an intersexual female in his *M. mirabilis.* In this specimen the female sexual organs were well developed, but on the tail end male copulatory organs were to be seen; a male gonad was absent (Figure 11).

Hagmeier observed intersexes in what he terms *Mermis terricola* Hag. Among twelve specimens two were intersexes (Hagmeier calls them hermaphrodites); both had the appearance and size of females; ovaries, uteri, vagina and vulva were well developed; in the uterus of one, ripe eggs were to be seen. But the tail was completely masculine. The spicula of one particularly large specimen were even larger than those of a normal male, but not so strongly, and somewhat irregularly bent, with knot-like thickenings. The sheaths of the spicula and also the long *retractores spiculorum* muscles were present, whereas the bursal muscles were present only in the tail end. The male papillae were typically formed.

The second specimen showed more irregular spicula and only a few male papillae, but here the bursal muscles were fully developed, even also orad of the male sexual opening, but in both cases Hagmeier was unable to find any traces of male gonads.

The same author observed also isolated bursal muscles in some female specimens of his *M. elegans, M. albicans* and *M. arsenoides.* Male sexual openings were often observed by him in females of *M. albicans,* but sometimes also in *M. elegans, M. arenicola* and *Paramermis fluviatilis.* Unfortunately we do not know the conditions here accurately enough to judge whether the above outlined explanations would fit. Further investigations will have to be

made before the matter will be cleared up. From my own observations I believe that variations similar to those described above for *Ag. decaudata* and related forms may be found in other Mermithid species.

Exactly why the Mermithids produce such an abundance of intersexes, is still unknown, and also why, apparently, only females show intersexual characters. Hitherto no one has observed, or at any rate mentioned, intersexual males in this family. In regard to *Ag. decaudata* it may, however, be mentioned that the number of the papillae on the tail end of the male is extremely variable, as is the arrangement also. It is hard to find even two specimens which are in this regard perfectly alike; also the length and even the form of the tail itself is somewhat variable as well as the length of the spicula (Figure 10).

Intersexes in Free-Living Nematodes

Apart from the family of the Mermithidae intersexes have been seen in very few other nematode genera. Somewhat outstanding in this regard is the genus *Trilobus,* including a number of fresh-water free-living forms. In 1905 (l. c. p. 55) E. von Daday describes a very pronounced case of intersexuality in *Trilobus longus* Leidy (*Trilobus diversi-papillatus* v. Daday.) It was an intersexual female. The ovaries, uteri and vagina of this female were well and normally developed, the vulva had its normal position and eggs were seen within the uteri. But this female had also well developed spicula, and, according to v. Daday, all the preanal accessory organs of the male, consisting of a group of three large, three medium-sized and numerous small preanal papillae. He claims even to have seen a short testis with a short *ductus ejaculatorius,* but apparently not functioning.

More often intersexes have been observed in *Trilobus gracilis* Bastian. Of this species Ditlevsen mentions a female with well developed male papillae, such as characterize the male, but without spicula and gubernacula. Recently Wilhelm Schneider observed two intersexual females of the same species. One had completely developed spicula but no trace of any papillae, the other female showed only three preanal papillae, whereas the spicula apparently were absent. Both specimens had well developed female organs. Dr. N. A. Cobb tells me that he also has observed on several occasions intersexual females in *Trilobus* at Washington, D. C., and Mr. Thorne tells me the same thing for specimens living in fresh water from Utah.

Regarding the causes of the intersexuality in this group of free-living nemas, it is of interest that, at least in *Trilobus gracilis Bastian,* there exist a series of races, genotypes or varieties already mentioned by several authors. I refer in this regard to the paper of Stefanski (1917), and one published by the writer (Steiner, 1919). Undoubtedly we have here a whole series of closely related, but slightly different forms, probably not all known. *Here, too, the observed intersexes may be related with hybridization between these different genotypes.* The abovementioned *Trilobus longus* is regarded by Micoletzky (1921) as only a variety of *T. gracilis,* but further studies have yet to prove the correctness of this conception.

Intersexes in Marine Free-Living Nemas

J. G. de Man mentioned in 1893 a thoroughly functional female of *Thoracostoma figuratum* Bast. with the spicula, and the gubernaculum of a male and a similar specimen of a female of *Chromadora poecilosoma* de Man.

In 1904 the same author mentions another very interesting case. Of nine specimens of *Enoplus michaelseni* v. Linst. found in algae growing on Gasteropods in the Bay du Torrent, Isle of Londonderry, Canal francais, Antarctic, he observed three females (they were the largest in size), with very pronounced intersexual characters. Two of them had eggs in the uteri; all three had the preanal, ventro-medial cutinized gland outlet of the male and also a

series of fine hairs between this outlet and the anus as in the normal male. In regard to the spicular apparatus, the three specimens represented three transitional grades; in one the apparatus was very similar to that in the normal male. In the third female, however, it was totally different. (See Figure 11.)

Comparing the intersexes of the different species described above, it is very remarkable to note that the different organs involved in the transformation toward the male sex are not progressive. As in the intersex represented in Figure 7, the bursal muscles and the papillae are more developed than in the one sketched in Figure 8, where the spicula are of a more advanced type.

Furthermore, comparing other cases mentioned in this paper regarding this character (f. c., also Figure 6), there are more such irregularities. It seems as if there is no correlation tending to produce gradual stages of development of the different sex organs. Where in one specimen an organ may proceed far along in its transformation, in another it may remain much less developed when compared with other organs involved in the latter transformation. In a recent paper by Goldschmidt (1922), which has just come to my attention, he presents an explanation of similar cases in his broods of *Lymantria dispar*. This explanation may also be applied here. He states that the races of *Lymantria dispar* show a great diversity in the rate of their development, and also in regard to the initiation of differentiation of the various organs which are known to occur at different intervals of time. Inasmuch as these characters are heritable, the hybrids consequently also show differences in this respect. The variations in the rate and size of development of the intersexual organs are a result of these conditions.

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FRESHMEN MATRIMONIAL IDEALS

ROBERT T. HANCE
University of Pennsylvania.

THE characteristics of the person I shall or did marry have been more or less filling the columns of various magazines for the past few years and the mirror has been held up to wife and husband (particularly the latter), most mercilessly. Far better would it be if the holder of the looking glass had been a bit more previous in this occupation in order to save the distressing postmortems and to eliminate the enervating sex triangle plots of the modern middle grade publications. The possible plea of these writers that their stories will bring greater happiness to the readers will not bear the scrutiny of logic, for in them, as in the quack medicine claims, each one may always find symptoms that fit his own case with apparent exactness. To a certain point ignorance is no doubt bliss, but it may also be stupidity and in this case end in disaster.

Believing, contrary to current opinion, that people, given the opportunity to talk are occasionally stimulated to think, the writer has always made openings for a general discussion of matrimonial ideals and desires when such subject matter might naturally crop up in his zoological teaching. Since few men are given to thinking very heavily or exactly on the qualities necessary to complement their own admirable personalities, open discussion of home problems is sure to present new vistas beyond the present requisites of sunrise complexions and a half bushel of more or less artificial hair. The opportunity to talk does gradually bring out opinions and the interest soon becomes such that the students forget to talk for effect and begin to put into words what they have never really considered concretely.

In a recent examination the following question was given to get some written statement on this subject from a large number of college freshmen:

> The aims of genetics and eugenics have been elaborated in discussions and in your readings in the books of Guyer and Conklin and by this time you should have some appreciation of what can be done in the way of perfecting all forms of life through proper selection and breeding. Obviously it is impractical, not to say impossible, to apply the same rigorous methods of selection and mating to man as is done with the lower organisms. Laws along these lines must consequently be ineffective and the greatest hope of improving the human race is through a comprehensive educational program.
>
> The importance of the proper selection of mates is great, both as regards the possibilities of the future generations and as regards the happiness of the individuals concerned. It is important that men and women have a clear conception of the type of person with whom they will be most likely to live in harmony.
>
> Write an exposition on "What characteristics I believe to be necessary in the person I shall some day marry." Discuss this question from the point of view of individual as well as racial happiness and success as fully as your information permits.

There is little reason to doubt the sincerity of the writers, for it was very easy to recognize an answer written to impress the reviewer. The answers have been strung together into a continuous tale and follow.

The Ideal Husband

The famous admonition, "Women and children first," requires that we consider the attitudes of the Co-eds on matrimonial ideals before we do those of the men. General experience indicates that on the whole the women frequently have a bit more concrete, definite and worthwhile ideas on the subject of the qualifications of their mates, suggesting that they probably have given the matter more attention. Their statements tend to be, I think, a bit less

stereotyped than those of the men, who are apt to have acquired their eugenics pretty largely for a definite occasion.

As can well be foretold, the requirements cover relatively few general topics though the variations under each of these are as many as there are writers. Pre-marriage frankness, and physical and mental characteristics in relation to personal tastes and to the production of fit children form the central theme of most of the records. The latter is the more remarkable in that in these days of fractional offspring per intellectual capita most of the writers seem to be figuring in terms of the whole number, and even in some instances in the plural.

There seems to be some real appreciation of the value of physical appearance as an index to health and it is seldom that the valuation is wrongly stressed on the "beauty" side alone. Throughout the papers run expressions in regard to physical well being and similar basic desires, differing only in terminology. To suit our Co-eds a man must be of "good appearance," "physically sound," must possess "strength and proportion," "cleanliness," and alas for someone's ideals, "he must be physically perfect." Considerable stress is laid upon cleanliness which may give some pause for thought. One logically points out that "sickness interferes with a pleasing personality."

Possibly with the physical traits might be indicated the realization of some of the difficulties of interracial alliances. These expressions naturally come mostly from the Jewish girls. An element of patriotism seems to influence some in arguing against foreign matches. One girl maintains that her children could not be pure-blooded Americans if the father was a foreigner. It might be of some interest to have her definition of such homozygous American stock and also that of the person whose ideal is a "real American of English, French, or Spanish descent."

The demands in the intellectual field are just as rigorous as in the physical. The male mate must possess refinement, have personality, be broad-minded, be intellectually superior, must "be of the sort that I would be willing to have my friends meet," and lastly and probably most important, "he must possess real understanding which leads to true companionship." One girl has clearly seen that there must be mutual concessions in order that understanding and real companionship, with the resulting great affection, will reign supreme.

Hybrid Creeds

Some anticipation of the difficulties caused by crossing creeds leads a few to foreswear matches involving such possibilities. While religion has been mentioned by a very few still, it is a very active part of one girl's ideal, who must qualify, according to her terse statement, as "healthy, clean, white and a desciple and lover of Jesus Christ, our Lord."

The increasing expectation of premarital discussions and frankness cannot fail to produce desirable results. We cannot help but feel that the writer of the following lines is on the right track and hope that she will meet her match "who must be able to talk frankly of marriage and its relations in order to have the right understanding. If he cannot, he has false modesty which is ignorance." Incidentally there is to be no condoning of wild oat farming, nor yet of intemperance of any sort.

It is a pleasure to note that a few girls—but none of the boys—know that the most essential mental characteristic needed to bridge over many of life's rough places is a sense of humor. If one can laugh there is at least small opportunity for crying unless, of course, one possesses a Celtic gene, when it is possible to do both at once and enjoy it greatly.

"The desire of all women is to have healthy children" though possibly open to debate on at least one score, still expresses an issue that is not dodged by any. Unless they fall down when

it comes their turn to face the reality, we may expect more from them than the traditional portion of an offspring statistically allotted to each college graduate.

Among minor desires falls the hope that the next generation will be "curly headed" so that they will not be afflicted with the female curse of straight hair. The man of one pair must be "strong enough to hold up his end of the argument, otherwise he'll be apt to get the worst of it."

In reviewing the statement of the women, I think, that they all show desires that are apt to make for stable happiness. The women seem willing and anxious wholly to do their part in making mutual concessions and to take up the increased burdens. Selfishness—a characteristic believed to be dominant in a class of women today—appears in only one instance and for the possible man's sake we hope with the writer that she'll "never be foolish enough to marry anybody" for if she did she has in mind more restrictions than a League of Nations.

The Ideal Wife

In turning our attention to the hopes of the males, we find very much the same ideals running through their discussions. Most of them really seem to believe that beauty is as beauty does and so long as a girl is free from abnormalities more cannot be expected. A reviewer may have just a bit of skepticism on this point and feel that on man more correctly expresses the usual instinct when he claims that while the male ideal need not be good looking, still that is a very nice characteristic to have. At least some sages are to be graduated, for out of the mouths of babes comes the information that "looks make little or no difference although the saying goes 'if you want to know your wife at fifty, look at her mother now.' "

We again hope that writers are sincere in desiring women of mental attainments equal to their own. Many want mates to balance their peculiarities—mates who can take things as they come—a few require parlor tricks or a mate who will in general "speak my language," and lastly, to counterbalance the sense of humor desired by the women, we have from the men the expressed hope for a girl with common sense. Whether we may classify as a mental attribute the necessity of the girl's thinking, "I am the best man this side of heaven," is doubtful.

Ability to manage a home and to cook is the materialistic expectation of many and to this one man adds that his woman must have ambition to get up in the morning and dress. Companionship is realized to depend upon common interests and congeniality and finds able expression in the phrase, "harmony is a good thing in any enterprise."

The mixing of races is believed to be dangerous to happiness by the Jews. Religion is very frequently mentioned as a good thing to look out for in matrimonial planning. There seems to be some agreement on the proposition that "religion keeps men together, but ruins all aims of genetics and eugenics," but the chap who wants a "Christian—not a Roman Catholic"—might strike fire in some circles.

We can see a very fair tendency in the men to pass up their time-honored right to distribute wild oats in such statements that "she must be healthy and fairly young and like Caesar's wife 'above suspicion.' It is unjust for a man to expect more than he gives." Or again "the musculine sex seems to be much interested in finding a mate with all the characteristics that will help to elevate their children, but how is it possible when the father is generally the one who is pulling down the moral standard of mankind daily."

Children are expected and wanted and the value of healthy parents is appreciated. One man goes the Eugenists one better by insisting on knowing the girl's "family skeleton." One optimistic pessimist concludes that the standards set auger bachelorhood for him.

Through what has just been read runs, what I really believe to be, an honest expression of opinions which seem to be basically good and may indicate that the reason for the usual success of college matches lies in the clearheadedness of the participants. It is a matter of opinion which sex as here recorded is better versed in the requirements of dual happiness, or whether the honors are not evenly divided. That many of the ideals will be altered in the years preceeding their realization is fully to be expected, but if only a portion of these hopes materialize we have a fair basis for a satisfactory home life. Consideration, unselfishness, a sense of humor, with its running mate common sense, can lead to little else than affection. These requisities the college freshmen seem to glimpse more or less clearly and it is encouraging.

At any rate we can gather a composite picture of the ideal college mate from the foregoing, but we must admit that all the tragedy was not penned by Shakespeare for the lament arises in the words of the victim "this dear friend, is my ideal and I think that I have found her. But—last July she announced her engagement to another, so my house of cards has fallen." But on with the dance—another concludes with the exclamation—"now let me look for that woman"!

Hygienic Marriage Laws

Das Aertzliche Heiratszeugnis, Seine Wissenschaftlichen und Praktischen zur Frauenkunde und Eugenetik No. 2. Pp. 72. Leipzig, Verlag von Curt Kabitsch, 1921.

The desirability of having applicants for a marriage license present a certificate of medical examination has often been urged, and has been given expression in bills offered at one time or another in almost every state legislature of the Union. Some states have actually adopted such a law, but the administration of these statutes has not given satisfaction to either friends or enemies of the measure. The principles underlying such legislation are discussed from almost every point of view, by eight specialists whose addresses are assembled in the present book.

A law providing for medical examination before marriage is frequently described as eugenic; it is, however, largely hygienic, although two classes of conditions are naturally dealt with, the inheritable and the infectious. In the United States the expense is charged to the applicant, but the German students hold that the state should provide the examination without cost.

Nearly all of the German writers here represented are opposed more or less strongly to the compulsory medical examination before marriage. The grounds are exceedingly various, but the lack of competent examiners (especially of women physicians) is one of the most serious. Dr. Hirsch, in the concluding paper of the series, makes a strong plea for the compulsory examination but holds that it should not be associated with any prohibition of marriage. The candidates for matrimony should be required to know their own condition; then it must be left to them (save in exceptional cases of insanity, already covered by law) to decide whether or not they are fit to marry.—*P. P.*

AN ORNAMENTAL PARASITE

RAISED BY THE JAPANESE TO DECORATE BAMBOO CULMS

Tyozaburo Tanaka
United States Department of Agriculture.

BASKET DECORATED WITH ARTIFICIAL FUNGUS INOCULATIONS

Figure 12. Rather an unusual industry is carried on by the Japanese to maintain the supply of fungus-infected bamboo culms that are used in making basketry and other ornamental objects. Different species of fungi produce different shapes and colors of spots on bamboo. The varieties that are most in demand have recognized "trade names," and the fungi producing them are propagated artificially. Photograph by E. L. Crandall.

PARASITES of economic or artistic importance tend to raise their class from the ill repute they commonly enjoy. In the West the mistletoe is cherished for its prettiness and Yuletide associations; the Eastern peoples cultivate parasitic fungi because they ornament the bamboo culms on which they grow. The beauty thus obtained has economic value, for the

bamboos are used in making baskets, flower pots, chop-sticks, utensils and other objects.

Different fungi produce different shades and types of ornamentation. The best known among the culm-infecting fungi is *Miyoshia fusispora* Kawam which attacks the bamboo *Arundinaria Narihira.* The large oblong patches of various shades, formed by this fungus, produce an ornamental effect for which such bamboos are highly valued. The natural habit of the fungus is complemented by inoculations artificially made to give the patches their right position and shape. The infected culms are cut down at the proper time and patiently polished to enhance their appearance. A good *Miyoshia* spotted bamboo often will cost several hundred yen (about two hundred dollars) when it is worked out as an attractive flower base or Chadogu (various utensils used in the tea ceremony).

Fungi decorating their hosts in manner different from that of *Miyoshia* are also widely cultivated. Small dark-colored spots caused by *Melanconium Shiraianum* Syd., *Didymobtryum Kusanoi* P. Henn., or *Eutypa Kusanoi* P. Henn, produce other ornamental effects on bamboo culms. The first species has been known since ancient times as *Také no sabi* or the rust of bamboo culm.

According to Sydow (Hedwigia, 1899, p. 144), *Melanconium Shiraianum* forms dense shiny black spots one-half a millimeter in length, taking an elliptic form on the culms of certain kinds of bamboo collected by Professor Shiria at Komaba, who identified this as the well-known *Také no sabi.*

The basket here illustrated was secured by Dr. W. T. Swingle in Japan in 1898. An examination by Miss Vera K. Charles, assistant mycologist of the Bureau of Plant Industry, United States Department of Agriculture, showed the fungus on this basket to be incompletely developed. Its appearance suggests Munkiella, which is the perfect stage of *Melanconium shiraianum.* The identification could not be made positive, however, owing to the immaturity of the fungus, development having probably been arrested by the treatment received in the preparation of the material for weaving.

A Textbook of Embryology

LEHRBUCH DER ENTWICKLUNGSGESCHICHTE, by DR. HERMANN TRIEPEL of Breslau. Two revised volumes. Pp. 210; 173 illustrations. $1.90. Leipzig, George Thieme, 1922.

In a compact but clear style, Dr. Triepel covers the ground belonging to an elementary course in embryology. While most of his data are drawn from the comparative study of various classes of animals, he deals adequately with man, and his material on the phenomena preceding zygosis is ample. The illustrations, all of them from drawings and mostly the work of Helene Limpricht, are particularly noteworthy.—*P. P.*

AGE AND AREA

A REVIEW OF J. C. WILLIS' THEORY OF THE ORIGIN OF SPECIES

Hugo de Vries

Lunteren, Holland

IN a series of articles, published during the last twenty years, J. C. Willis has tried to show that the dispersal of plants is governed by general laws and independent of so-called adaptations, or of any kind of advantageous response to local conditions. The main factor of distribution is age, a cause which works in the same manner on all plants. The rate of expansion of area is a fair measure of age. The most widely distributed genera and species in every family are to be considered as the oldest within that group, and, taken broadly, the remaining ones must be progressively younger, the smaller the area they occupy. Number of species usually goes parallel to geographical area, and therefore the genera which are richest in species will also, as a rule, be the oldest of their group. Senecio, with 1500 species, has been the source whence the family of the Compositae has been developed. Astragalus with 1600 species is at the bottom of the papilionaceous plants and other large genera could easily be added.

Of course, age in itself is not the cause of distribution; it only allows the time for this process. Moreover, when one considers single species, as has been done most generally in plant-geography up to this time, the influence of adaptations, of dispersal methods and so forth may easily lead to the conception of special laws for different forms. Therefore it is necessary to study averages, instead of single cases. In doing so it is found that the resultant effect of the active factors, biological as well as ecological, is very uniform and almost wholly the same for different families or for the members of different floras. Considering long periods of time and taking the species in small groups of allied forms (e. g. of 10-12 each), in order to calculate averages, one finds that all plants spread at a fairly average rate.

The author has now collected his results in a book, entitled *Age and Area, A Study in Geographical Distribution and Origin of Species* (Cambridge, 1922, p.p. 259). The discussion of his law is founded here upon a broad basis, combining the results of the investigation of numerous local floras and comparing them on all sides with previous views. Many objections and many criticisms had already been published by different authors and they are now dealt with in such a way as to insure the validity and the general applicability of the main law. Confirmations have also been numerous and among these I might cite the work of J. Small upon the evolution of the Compositae. In a chapter on this group, inserted in Willis' book (pp. 118-136), Small shows that the pedigree of this family, as derived from the morphological characters of the stigma and the stamens and from the study of the fossil fruits found in the deposits of the tertiary period, wholly agrees with the predictions which can be made from Willis' law. Expansion of area, and number of species, if calculated in averages for the different tribes and subtribes, are almost exactly parallel to the ages derived for them from systematical and palaeontological data.

The Flora of Ceylon

Willis started his statistical researches with a study of the flora of Ceylon, and afterwards applied his results to

that of other oceanic islands and of other more or less isolated regions, finally covering the flora of the whole world. For this reason it seems desirable to consider the island of Ceylon here also, in the first place. Such a process will at once put the meaning of the general law in a clear light.

The flora of Ceylon embraces 2809 species of Angiosperms, of which 809 are endemic to the island. Of these latter about 200 are confined to very small areas and about half of these occur upon the tops of single mountains or on small groups of mountains. There are 1027 genera, of which twenty-three are confined to Ceylon, and among the 146 families this is the case with six. Most of the endemic genera are represented by one species only, four by two or three and only two (Doona and Stemonoporus) by a larger number. The endemic types are well marked Linnean species and as such sharply distinguished from their nearest allies, but a comparison of their characters does not reveal any qualities which could be regarded as useful under the conditions of their localities. On the contrary, it is evident that they do not surpass their more widely distributed allies in this respect. Moreover, many of the endemics occur as a very few individuals, say only a dozen or more, and the places where they can thrive are often so small that it is obvious that they can never have been much more numerous.

These facts lead to the conclusion that the endemics are not, as a rule, the remnants of forms which previously had a wider distribution, but which are now gradually dying out. In the temperate regions of the northern hemisphere there are a great many endemics of this kind, and they are usually designated by the name of relics. They are the survivors of species which were widely spread during the tertiary period, as has been proved in many instances by the study of their fossil remains. But there is no good reason to apply these results to the Ceylon endemics, nor to those of tropical and subtropical regions in general. Moreover, the northern relics are rare as compared with these. North America has only about 400 such forms, whereas the small island of Ceylon has 800 endemics, as has already been stated. Brazil has 12,000 such species, New Zealand and many other oceanic islands are even richer in them, when areas of the same size are compared. The real relics may be estimated at one or two per cent of all the endemics and therefore they cannot be considered as indicating the general condition of the forms of this group.

Willis proposes the conception that most of the endemics of Ceylon and of other similar regions are, quite on the contrary, the youngest members of their flora. They must have originated on the same spots where they are found now. And, since most of them have the same means of dispersal as their more common allies, it seems evident that if time were allowed, they would spread like these. The smallness of their area can therefore only be explained in a satisfactory way by assuming that they have not had the time to gain a larger territory. As soon as this main point is conceded, it is obvious that the size of the territory occupied by an endemic species is to be considered as the result of the lapse of time during which it has been able to spread. Or in general terms that the area covered is a measure of the relative age of the species under consideration. Age goes parallel to area, and this, condensed into its smallest form, is the meaning of the phrase, *Age and Area.*

Of course, this rule cannot be restricted, either to the plants of Ceylon or, on the other hand, to endemics only. If true, it must embrace all species of organisms and all geographical regions. It must be the main law which governs the geological and geographical evolution of the whole living world. Distribution must go on everywhere on the same general lines, it must be

independent of special organizations or so-called adaptations.

In following this discussion, many readers will object that there are too many single instances which do not seem to be in accordance with this new law. In order to reply to this objection, Willis has introduced his principle of averages, or what we might call his statistical method. A general law can only be extracted from the study of individual cases, if these are combined in sufficient numbers to smooth the effects of their special features. Age and area should not be used as a comparison of single cases, but for small groups of allied forms, such as the species of a genus, the genera of a tribe or the tribes of a family. Experience has proved that averages for groups of about ten such types suffice to eliminate the effects of most of the deviations. Whenever possible, groups of fifteen to twenty species should be preferred. In doing so the method may be extended to biological or ecological groups of plants as well as to systematical ones.

When one considers such groups and compares them with other related sections, the effects of age will show clearly, because the other factors in dispersal will either be pulling the same way upon all, or will cancel one another by pulling in different directions. Age, however, is always pulling alike upon all species. The greater the number of allied forms taken, and the greater the length of time considered, the more clearly will the effects of age show.

In applying this statistical method to the flora of Ceylon, one has to compare two main lines of geographical facts. One of them relates to the probable age of the species, the other to their present distribution on the island. Three main divisions are proposed, one containing the endemic species, the second those confined to Ceylon and Peninsular India, and the third the forms of wider distribution. The distribution on the island itself is derived from the data given in *Flora of Ceylon,* by Trimen and Hooker. These authors divide all species into six classes, viz.: 1, very common; 2, common; 3, rather common; 4, rather rare; 5, rare; and 6, very rare. The number of species belonging to each of these classes is then multiplied with the factor indicating their degree of rarity, and this is done for each of the three groups of different dispersal. From these figures averages may be calculated, which give the degree of rarity for any group under consideration. In this way Willis finds.

	No. of Species	*Rarity.*
Mean rarity of all species...	2,809	3.5
Species of wide distribution..	1,508	3.0
Of Ceylon and Peninsular India	492	3.5
Species endemic to Ceylon...	809	4.3
Species of all the 23 endemic genera.	52	4.5
Species of Doona (endemic).	11	4.6
Species of Stemonoporus (endemic)	15	5.4

From this table we see that the species of widest distribution are the commonest, that those of Ceylon and Peninsular India have just the mean degree of rarity, whereas the endemics are relatively rare. The species of the endemic genera, and especially of the only two genera which are rich in endemic species, are the rarest of all on the island. Further tables, which cannot be reproduced here, show that the different families of this flora behave in the same manner, showing that no one family has any particular advantage over another. The same rule prevails for the genera and even for ecological groups of species. Everywhere the order of rarity within the island is parallel to the degree of the distribution outside of it.

Confirmation of this law was then obtained by working out the flora of New Zealand, of the Hawaiian archipelago and of other oceanic islands after the same method. The orchids of Jamaica, Callitris, a coniferous species of Australia, the ferns of New

Zealand and many other groups gave the same result, showing that the law is quite general. Other authors have contributed analogous data for the grasses of Australia, for the endemics of the Bahama Islands and other cases. Everywhere the statistical method, just described, conduces to the same conclusions.

In stating the rule in a general way, some restrictions will, of course, be found to be necessary. For this reason I wish to quote the most recent expression of these as given by the author: "The area occupied at any given time, in any given country, by any group of allied species at least ten in number depends chiefly, so long as conditions remain reasonably constant, upon the ages of the species of that group in that country, but may be enormously modified by the presence of barriers such as seas, rivers, mountains, changes of climate from one region to the next, or other ecological boundaries, and the like, also by the action of man, and by other causes."

The main point in this contention is, that the species have to be considered in small groups of allied forms. If single species are studied, the distribution will of course depend upon many factors which, however, cancel one another as soon as the statistical method is applied to them. Among these factors the most prominent are given by the means of dispersal, acclimatisation, suitability to the society of plants in which a species may find itself, barriers of all kinds, whether physical, climatic or ecological, individual habit of the species itself, and so on. But these factors will be different for the individual species, whereas age works on all of them in the same sense.

Or in other words, while the possession of a good mechanism for dispersal may be of great advantage to a plant, especially in reaching areas that are only a small distance away, it is by no means essential for world-wide distribution.

Origin of Species and Natural Selection

On the basis of these statistical results the theory of the origin of species by means of natural selection of infinitesimal variations is subjected to a severe criticism. As a rule, the rate of dispersion of new species is independent of their special organizations, since it is the same for all of them. In the largest number of endemic species there are simply no adaptations to the local conditions. The new forms inherit their suitability to their environment from their ancestors, without any appreciable change or improvement. The systematical characters, which constitute them as good Linnean species, do not show any regular relation to their struggle for life. Considered from a biological point of view these new qualities are of very secondary importance.

From these considerations some very valuable deductions may be derived. It goes without saying that any new forms which should not, from the very beginning, be sufficiently adapted to the prevailing conditions of life, will soon be wiped out. But whenever the adaptation is the same as that of the ancestors, the chance of survival will also be the same. The new forms will develop and spread beside the older ones, and according to the same general law. There is no reason for assuming a further competition between the species, even if the struggle be sharp between the individuals themselves. The struggle for life, which took so prominent a place in the older theories concerning the evolution of the species, seems to be reduced to the very first period after their origin. New forms have not to conquer their ancestors in order to supplant them, nor to extirpate them in order to secure their places in the flora for themselves. The older species may simply continue their spreading beside their derivatives. Some of them may, of course, die out in the process, but this will be rather an ex-

ception. We are not obliged to regard a new species as coming into existence at the expense of its ancestors, as was assumed under the theory of natural selection. The areas now occupied are large enough to offer sufficient room to newcomers, provided these are as well suited to the obtaining local conditions as the previous inhabitants.

If the appearance of a new form does not imply the disappearance of its ancestors, the whole, or at least a great part of the family tree of existing species should still be surviving. It is commonly assumed that such pedigrees are often only incompletely represented by the existing forms and that many links have disappeared during the geological periods. Discontinuity in a pedigree could always be easily explained in this way. The conclusions of Willis, however, no longer allow the constant use of this method. If, as a rule, species survive beside the new ones evolved from them, there is no good reason to assume gaps of any importance between the members of any given family. The pedigree of the whole should still be represented in a practically continuous way by the totality of the living species. This is a simple and clear principle, which may free the systematists from superfluous hypotheses and at the same time make their conclusions concerning the affinities of the genera and species within a family more convincing and more reliable.

The Evolution of Species

Species are thus assumed to have evolved from one another by means of small steps and not by the slow and gradual accumulation of infinitesimal variations. It is now generally conceded that this latter theory can by no means explain the first beginning of the process. This view supposed the selection to take place as a result of some slight advantageous response to surrounding conditions. But the first steps cannot have had such a decisive degree of utility, even if the whole specific difference could be shown to possess it. In the differentiation of new species the steps must therefore have been of some definite importance. But how large have they been? This question has, at the present time, quite another meaning than it had half a century ago. We are now accustomed to consider the qualities of organisms as built up of units, which are usually designed as hereditary factors or simply as factors. In experimental work we rarely know whether a factor is really simple or still a compound entity, since in so many cases factors originally assumed as simple have been split up into minor units in the course of further researches. Leaving this difficulty aside, the question remains whether the steps which have produced the existing species are to be considered as involving each a single factor or a small group of such.

Willis replies that such changes may at times occur of the necessary size to give rise at once to Linnean species. The elementary species of *Draba verna* and of numerous other plants, described by Jordan, are often looked upon as constituting the steps by which species have been evolved in nature. In order to get real Linnean species we could suppose large numbers of the small species of *Draba verna* to die out, since the differences between the remaining ones would then evidently increase, and might easily reach the degree necessary for them to be admitted as good species. But there is no good reason for the theory of dying out, and the discoveries of Willis show such a process to be rather an exception in nature than a general rule. The Jordanian varieties show the same phenomena of dispersal as do ordinary Linnean species. Often they occupy as large areas, while they still remain true-breeding, and show no sign of variation. Jordan himself has always described them as members of well known good species, not as intermediates between such. Evidently they do not constitute the steps which previously might have linked existing spe-

cies, nor those which would normally lead to the origin of new species. From this we must conclude that mutations giving rise to new forms in nature may vary in size in the same way and in the same degree. Some of them will produce Jordanian types, but others will give Linnean species. It seems that this is the general rule, though it must be conceded that in exceptional cases the dying out of intermediates may have contributed to the now existing differences. And if we consider the probable connections between the families themselves, and their evolution during the primary and secondary geological periods, it is at once clear that the disappearance of linking types must have played more than a subordinate role.

Therefore we must conclude that, as a rule, or at least in a vast majority of instances, species have been derived from one another by single steps, embracing the whole of the differences indicated by the systematical diagnoses. The hereditary factors must change in small groups, say of two or three or some few more units. They must be assumed to be connected with one another, and not as free as the varietal factors, studied in hybridizing, usually prove to be. In this respect it may be of interest to cite the experimental mutations of the species of Oenothera. Here also the factors do not, as a rule, change one by one, but almost always in small groups. Every new type is distinguished from its direct ancestor by quite a number of characters, giving a diagnosis of the same size as those of the wild species themselves. In the beginning these differences have been looked upon as units, afterwards as compound factors, and of late an analysis has been attempted, in order to separate the true constituent units. But this study has encountered, until now, the same difficulties as are opposed to a factorial analysis of specific diagnoses in general. In the meantime we must be contented with acknowledging the fact that the directly observed mutations may, at least in some cases, be of the same nature as must be assumed for the origin of wild species on the basis of Willis' theory.

The Origin of Genera

We may go one step further and consider the probable origin of genera. Have these been evolved by a series of steps and by the disappearance of the intermediate types? Or is their method of development governed by the same laws as that of the species? It seems probable that at least in many cases the response to the last question must be affirmative, since the assumed disappearance would include such a vast amount of intermediate types as is hardly compatible with the general laws of distribution. But there is another fact which may be adduced here. I mean the frequency of monotypic and ditypic genera, including only one or two species. They are very numerous, over thirty-eight per cent of the genera of the world containing only one species each, and about thirteen per cent containing only two. Monotypes and ditypes together constitute, therefore, more than half of all systematical genera. Genera with three, four or more species than follow in diminishing numbers and very large genera are very rare in almost every family. From this consideration we may conclude that there is no real difference between genera and species, except in size, and that therefore the origin of the first has been governed by the same general laws as that of the latter.

The same analogy that connects Jordanian with Linnean species is thus connecting species and genera also. The new law, that age goes parallel to area, and that the method of evolution and distribution have been, in the main, the same in all branches of the animal and vegetable kingdom, seems to be the principle which must direct all further researches in the geography as well as in the genealogy of the living world.

BOTTLE GRAFTING

A. F. Blakeslee and M. E. Farnham
Station for Experimental Evolution, Cold Spring Harbor, Long Island.

IT is well known that plant hybrids are usually unable to breed true when propagated by seed, but fortunately, in the majority of cases a desirable plant can be multiplied by vegetative means. Thus most of our fruit trees and our various named varieties of roses, tulips, dahlias, potatoes and many other plants are kept true to type by the processes of budding, grafting or propagating by cuttings or by vegetative means of reproduction such as bulbs, roots and tubers. By the chance union of Mendelian factors in hybridization many combinations of characters are possible, and it is usually the rare combinations which give us our choicest varieties. These choice varieties are usually highly complex hybrids, and in consequence the mixture of factors which they contain segregate and produce new combinations in the formation of pollen and egg cells. This is the reason that they cannot breed true by seed. Seedless methods of multiplication are of value not only to the practical plant grower but to the plant geneticist as well, who frequently wishes to carry over individual plants from one season to the next in order to use them in his breeding experiments.

In our work with the Jimson Weed, for example, there are many forms which, when propagated by seed, give rise to only a small percentage of offspring like the parental type. Others like our Haploid and Triploid Daturas (with one-half and one and one-half times the normal number of chromosomes respectively) cannot ordinarily be expected to produce any seedlings like themselves, and therefore can be carried over only by vegetative propagation. Grafting has been found rather difficult with material which has been checked in its vegetative growth both by fruiting and by the low temperature encountered toward the end of the growing season. If the grafted plants were kept too moist they would tend to rot. If the surrounding air were not moist enough, they would dry out and no union would be formed between scion and stock.

To obviate the difficulties which have been enumerated the idea occurred to us of keeping the scion supplied with water during the formation of callus by immersing the base of the scion in a bottle of water. Such bottle grafts have been eminently successful and we are now able to graft readily slow growing forms with which we were formerly rarely successful. We have grafted even albino seedlings which had not yet shown any true leaves. The process in bottle grafting is relatively simple. Almost any method of grafting can be used, provided the base of the scion is left free for immersion in a bottle of water. The conducting foot should be long enough and project sufficiently to prevent capillary water from wetting the place of junction. We have usually cut the end of the stock to form a wedge which has been inserted into a cleft in the scion. In about two weeks a union is made and the wrapping of raffia may be removed.

The accompanying photograph (Fig. 12) shows various stages in bottle grafting. At the left is a purple-stemmed stock upon which a green-stemmed scion has just been grafted. The base of the latter may be seen inserted in a small bottle of water which is held to a stake by a rubber band. The pot in the middle contains a stock and scion which were similarly grafted

JIMSON WEED PROPAGATED BY "BOTTLE GRAFTING"

FIGURE 13. On the left is shown a "bottle graft" in position, with the end of the scion projecting and immersed in a small bottle of water. This prevents the scion from wilting before union with the stock occurs. On the right is shown a completed graft in which the end of the scion has not yet been trimmed off. On the plant in the center the projection has been removed so that the point of junction will heal over smoothly. "Bottle grafting" is really a modification of the older method of inarching in which two living plants are placed side by side and grafted together.

at an earlier date. The base of the scion which acted as a feedpipe for water has been removed and a single band of raffia protects the union and prevents it breaking at the joint before it has been strengthened by the formation of woody tissue. The pot at the right contains a green-stemmed stock upon which has been grafted a purple-stemmed scion. The foot of the latter which connected with the bottle has not yet been removed and may be seen as a small projection on the left.

Obviously bottle grafting is merely a modification of inarching or the grafting together of two plants which are growing side by side. Doubtless this method has been used by others, since it is a natural means of obviating the difficulties encountered in attempting to graft slow-growing scions. It is not mentioned, however, in Bailey's *Standard Cyclopedia of Horticulture,* nor is the method known to a number of horticulturalists and botanists with whom we have discussed the method. We are publishing this brief note, therefore, to call attention to a method which we believe may be of considerable use to plant geneticists in keeping alive exceptional breeding material.

Blood Tells Again

The Colorado Endurance Ride takes place each year to stimulate interest in the breeding and use of better saddle horses. It is a gruelling test of endurance, which only a fine horse can survive. The distance covered is about three hundred miles. The contest lasts five consecutive days, the daily course averaging about sixty miles. Each horse is required to carry 225 pounds.

It is an interesting fact that this contest, like the races for speed, goes to the pure-bred horse. In former years scrub horses have been allowed to enter, but in 1923 they are barred for the reasons given below:

"A provision adopted for the Colorado Ride of 1923, which has always pertained in the East but was not heretofore prescribed in the West, is that which requires that a competing horse be at least a half-bred of some recognized breed; in other words, his sire or dam must be a pure bred.

The Sponsors' Committee when considering this matter in 1922 recognized fully that, from many standpoints, it was a sheer waste of time to permit the entry of horses of unknown breeding; for even assuming the possibility that such a horse could win, no useful information would be derived from his performance, inasmuch as one would have no clew as to how to reproduce him. However, it was deemed wise to open the entries to scrub horses for one year, in order to render it abundantly clear to ranchmen that the proper type of blood horse excels the horse of no breeding at any task, whether it be running at high speed, or carrying weight for long distances. This having now been satisfactorily demonstrated, entries have been restricted to horses of known breeding, from whose performance useful information may be derived.

The Colorado Ride, while being in terms identical with that conducted in the East, will in fact be a very much more severe ordeal, due to the circumstance that on several days of the Ride the mid-day halt will be between 1,500 and 2,000 feet higher than the start on two more days it will be more than 1,000 feet lower. These heavy gradients, if negotiated successfully and with approximately equal speed, will unquestionably make a better showing for the Colorado horses."—*The Remount.* Vol. 4, No. 1, pp. 13 and 14.

THE STORY OF THE MAIZE PLANT[1]

A Review

THE story of the maize plant is a comprehensive title and the subject is encompassed in a small volume of 247 pages, including a bibliography and index. The motive which actuated the compilation of material for this story is based, according to the preface, "on numerous inquiries for specific information about the maize plant received by the author in the course of four or five years." Being a morphologist it is not surprising that the inquiries he received should relate largely to morphological features and this doubtless accounts for the emphasis placed on morphology in the present volume. The geneticists almost certainly will feel that their investigational field has been given scant treatment, but this feeling may be due somewhat to prejudice and after all the brevity with which genetics is treated may prove a blessing.

There can be no question as to the intensely interesting character of the morphological problems found in maize and the contributions on these, which largely are a reassembling of the author's previous works, are welcome and, combined in one volume, may be said to fill a long-felt need.

The inclusion of material other than morphology was doubtless at the insistence of the editorial committee prompted perhaps by the desire for an appealing general title and the result, as might have been anticipated, has been to dilute a good morphological treatise with irrelevant and often archaic ideas. The chapters on tillage will scarcely meet the approval of the agronomists and the incongruity of presenting descriptions of corn planters and harvesters between the detailed histological accounts of the root system and floral organs will be patent to all. One misses the familiar drawings of the farm implements discussed and it is to be hoped that this oversight will be corrected in later editions.

A comprehensive bibliography is appended which may be as good as those in many similar publications, but a hasty perusal of the titles affords little clue as to what influenced the choice of references. Throughout the text it seems to have been largely a matter of chance whether or not the sources of information were cited, though an exception has been made with the historical references where it was obvious that the author could not have made the original contributions. Perhaps the most conspicuous omission is the failure to refer to the work of Hayes and East in the extended discussion of the floury-corneuos crosses.

The arrangement, which should not be charged to the author alone, being also a responsibility of the editors, seems capable of improvement and much reference back and forth throughout the text as well as some needless repetition seems avoidable.

The author is to be congratulated on having receded somewhat from the dogmatic utterances of his technical papers—a hopeful sign that increasing experience will bring about true scientific openmindedness. It is interesting to note, however, that he still feels that observations based on other than embryological characters are superficial and promise only a "precarious base for philosophic consideration."

There are three minor departures from accepted nomenclature. Thus the author throughout capitalizes the specific name of Zea (mays), places an accent on the final "e" in teosinte and

[1] WEATHERWAX, PAUL. The Story of the Maize Plant. University of Chicago Science Series. 247 pages. 174 figures. 2 colored plates. University of Chicago Press, March, 1923.

designates the grass family "Gramineae."

It is well to note that the range of teosinte is given as including Central America. This may seem a minor point, but taken in connection with the area covered by the civilization of the Mayas, it is extremely important to know whether this ancestor of maize existed in their terrtitory. For several years past we have been endeavoring to verify the occurrence of Euchlaena as a wild plant in Central America, but as yet these efforts have been abortive. Until definite information is obtained it seems undesirable to extend the range of this species to include Central America. (See Hitchcock, A. S., *Jour. Wash. Acad. Sci.*, Vol. 12, No. 8, P. 205.)

It is apparent that the author still fails to appreciate the true nature of prophylla. One harldy would have expected a morphologist to overlook the fact that two buds often are developed in the axil of the prophyllum of maize and doubtless the vestiges of these buds always are present. This is all the more surprising in view of the author's predilection for vestigial organs.

The absence of satisfactory morphological evidence of buds at the upper nodes does not seem to suggest to the author the possibility that such buds do not exist. This failure to abide by the morphological rules of his own making is evidenced elsewhere. While it is not wished to stress unduly the fasciation hypothesis of the origin of the ear it seems only fair to the adherents of such an hypothesis to ask why the lack of histological evidence for fasciation in the development of the ear should preclude this explanation when the same lack of evidence is not considered in the case of the normally fasiated stigmas and of conate seeds.

There are numerous misstatements and generalizations which should be corrected; thus on page **20**—"Pod corn frequently appears by regressive variation in any variety" and on page **117** "Functionally perfect flowers are of rare occurrence" and on page **141**, "Six-rowed ears have never been known to occur." The first and last of these statements, of course, are not according to the known facts and while the other may be a matter of opinion, there can be little question that the mutations to pod corn are much more rare than the occurrence of perfect flowers.

On page **38** we read "At about this time, or a little later, the last of the food stored in the endosperm is consumed and the new plant begins its independent existence." Notwithstanding this statement it is extremely doubtful whether a normal germinating maize plant consumes the last of the food stored in the endosperm and indeed the storage of material in the seed in excess of what is normally used is one of the outstanding features of the large-seeded varieties of maize.

On pages **44-45** it is stated "above the first or second internode wholly above the ground the succeeding mature internodes are thinner and longer" and on page **57** "In this branch the uppermost internodes are short, and the lower ones progressively longer—a condition exactly opposite that prevailing in the main culm." We have measured all the internodes on hundreds of maize plants and have found that in a vast majority of varieties, including the common commercial strains the longest internode is well below the ear and usually is midway between the lowest and the uppermost.

On page **78** "The best known and probably the most destructive disease of maize is smut or brand." This will reassure the growers who may have become alarmed by the root-rot propaganda.

On page **107** the author shows great caution in accepting the hereditary nature of fasciation and the inheritance of branched forms of ears is disparaged as being nothing more than

sporadic mutations. But what more is expected of them?

On page 184 we note that first generation hybrids are used extensively. Although the extensive use of such hybrids is greatly to be desired the above statement must be taken as a prediction rather than a fact.

These statements illustrate the futility of generalizations about this species and whenever found they should be the subjects of reservations by the reader.

It is to be regretted also that the distinctive name *brachytic* has been applied to an entirely different and unrelated form of dwarfing from that originally published under this designation.

It seems worthy of note that the abortion of parts ["which seems a characteristic of theories demanding it for consistency"] is now recognized as a common phenomenon in the normal development of the sex organs.

In the discussion of maize-teosinte hybrids the author discounts the results obtained thus far and urges postponement of further investigations along this line. The efforts of morphologists in the past, however, have not been such as to encourage geneticists to postpone further analysis of maize-teosinte hybrids with the hope that a "sound working basis of morphology" will be available.

Had the volume been limited more definitely to morphology, a field for which the author seems eminently fitted, it could have been recommended highly, having no more than the usual errors of observation and interpretation, but as constituted at present it falls seriously short of presenting the story of the maize-plant.

J. H. KEMPTON.

The Inheritance of Squinting

That squinting is definitely inherited, is the conclusion of Arthur Czellitzer, a Berlin oculist, who publishes a study of his cases in the *Archiv f. Rassen- und Gesellschafts-Biologie* (XIV, 4). More than 800 brothers and sisters of cross-eyed children have been examined, and data sought regarding their parents and other ancestors.

While the frequency of squinting in the general population is reported to be only one or two per cent, he found that 15.4 per cent of the brothers and sisters of cross-eyed patients were also affected. The author's pedigree charts lead him to the conclusion that cross-eyes depend on two distinct recessive factors. There seems to be some genetic difference between convergent and divergent strabismus, however.

P. P.

A Eugenics Advisory Bureau

A free public eugenic clinic is now open two afternoons a week in the Anthropological Institute of the University of Munich, Bavaria. An anthropologist and a physician are in attendance, to help inquirers to study their family histories intelligently and learn their own genetic constitutions, so far as is possible. The examination results in the preparation of a detailed report, of which one copy is given to the applicant and the other (identified only by a serial number) is kept by the Institute for the use of research workers. A charge is made for special services such as photographs and X-ray examinations. The bureau is known as the Beratungstelle fur biologische Familienforschung.

P. P.

NAKED OATS

T. R. Stanton

U. S. Department of Agriculture, Washington, D. C.

THE naked or hull-less oat is without doubt the proverbial "black sheep" of the cultivated oat family. In appearance it is very attractive and interesting, but it is always short on performance. Its oddity and attractive appearance make it readily salable to those who do not know it, and consequently it has been considerably exploited.

During the past fifty years naked oats have been advertised several times as a valuable new variety, with extravagant claims as to their yielding power and usefulness as compared with common oats. The purchaser in every case was "gold bricked" and became the unfortunate victim of the clever advertising of the promoter. The promoter's agents, traveling from farm to farm, showed with great enthusiasm a few kernels of the naked oats in small vials which they carried with them, proclaiming it to be one of the marvels of the age.

In the decade from 1870 to 1880, naked oats, under the name of Bohemian oats, were for the first time widely exploited in this country. They were known prior to this, but apparently had been given no serious consideration, especially as a plant novelty that would lend itself readily to spurious exploitation. During the period of the Bohemian oat scandal the seed was sold for as much as fifty cents a pound. The Bohemian oats were rather widely distributed, but farmers discovered that they were greatly inferior to ordinary oats and soon they had almost entirely disappeared from cultivation. However, sporadic exploitation of naked oats under other names has occurred up to the present day. Every spring the Office of Cereal Investigations, U. S. Department of Agriculture, receives letters from farmers requesting seed or information on naked or hull-less oats.

History

The origin of naked oats is not known, though they appear to have come originally from central and eastern Asia. This type of oats was grown in England as early as the middle of the sixteenth century. In some of the older English publications they are referred to as "peelcorn" and also as "skinless oats." Naked oats are now found in the dry Tibetan-Himalaya highlands in Russia and Chinese Turkestan, and in northern and western China. Indications are that they have grown in that part of the world for many centuries, the grain being used quite largely as human food. Practically all of the naked varieties received by the Office of Cereal Investigations were collected by the late Frank N. Meyer in the regions mentioned. He reports that they usually were found growing on sterile mountain sides at high altitudes.

Description

The chief distinguishing characteristic of naked oats is, as the name implies, the multiple-flowered spikelet with naked or hull-less kernels. The hull is not retained as in common oats, but the grain thrashes free from it. The number of flowers in the spikelet varies from three to twelve, the average number being about seven. The culms and leaves are similar to those of common oats, though the culm is usually shorter and weaker and lodges more easily. As in common oats, there are varieties with both spreading and side (horsemane) panicles, the latter being practically unknown in America.

A PANICLE AND SPIKELET OF NAKED OATS

FIGURE 14. The most desirable character possessed by the hull-less varieties of oats is the multiflorous spikelets (lower left-hand corner), which could be used to make hulled varieties much more prolific, were it possible to transfer the character to them. Unfortunately hull-lessness and multiflorous spikelets are very closely correlated or linked, and they never segregate separately in the second generation of crosses of naked by hulled oats. Naked oats is the black sheep of the family; it promises well but is always short on performance. Furthermore the grain does not keep long in storage as the lack of hulls seems to inhibit proper respiration. The panicle shown is of the variety known as Chinese Hull-less.

A PANICLE OF ORDINARY HULLED OATS

FIGURE 15. The variety is Swedish Select, one of the better commercial strains of oats. Note that only two grains normally develop on a spikelet, whereas in naked oats from four to twelve grains are found. Nevertheless the yield of this variety is much greater than that of the best varieties of naked oats. Naked oats are supposed to be native to Central Asia. They were introduced into England as early as the sixteenth century, and were called "peel-corn" or "skinless oats." They were known in this country early in the nineteenth century, but were not exploited as a superior "novelty" until 1870. At the time of the "Bohemian oats" scandal, seed sold for as much as fifty cents a pound.

There also are varietal differences in size and length of kernel, and in the presence and absence of awns. Panicles and spikelets of naked and common oats are shown in Figures 14 and 15, respectively.

Varieties

The number of varieties of naked oats is comparatively small. Most of the lots introduced into this country have been of the Chinese variety (*A. nuda chinensis,* Fisch.), with spreading panicles and with either awned or awnless lemmas. This variety is the one which has been most commonly exploited.

In recent years several new varieties of naked oats have been developed in this country by crossing the Chinese variety on some of the best common varieties. The most notable is that of the Liberty Hull-less, (Ottawa No. 480) (see Fig. 16) developed by Dr. C. E. Saunders of the Central Experiment Farms, Ottawa, Canada, from a cross between Chinese Hull-less and Swedish Select. Dr. Saunders succeeded in getting a stiffer strawed variety in the Liberty Hull-less, but in yield it apparently is not greatly superior to the Chinese Hull-less parent. It may also be slightly less susceptible to disease than the naked parent, all of the strains of naked oats which have been introduced into this country being very susceptible to smut and rust.

Recently the South Dakota Agricultural Experiment Station at Brookings has bred a new naked variety from a cross between Kilby Hull-less and Swedish Select. This new variety is practically identical with the Liberty Hull-less. One year's observation of this variety indicates that it is not superior to other naked varieties. The Department of Plant Breeding at Cornell University also has bred several new naked sorts from a cross between naked oats and Swedish Select.

Yield

The agronomic value of any crop variety is determined primarily by its yielding power. Naked oats have been included in a few scattered varietal experiments. The earliest reported experiments in which the naked variety was compared with ordinary ones were conducted by the University of Wisconsin at Madison in 1871. The results of these experiments as reported by McAfee,[9]* farm superintendent, shows that Bohemian Hull-less oats yielded 970 pounds of grain to the acre, as compared with 2,489 pounds of White Schonen, 1,992 pounds of common local oats, and yields of other varieties vary from 1,510 to 2,404 pounds.

In 1916, the Washington Agricultural Experiment Station at Pullman reported[10] some results with hull-less and other varieties of oats grown in 1913, 1914 and 1915. Only yields in grams per plat are shown, but these provide a basis for satisfactory comparisons. The average yield of naked oats for the three years was 1,456 grams; of Chinese Hull-less, 1,063 grams; of Abundance, 3,246 grams, and of Banner, 3,248 grams. If the yields of these two latter hulled varieties are reduced by twenty-five per cent, the approximate weight of the hulls, they are still in excess of 2,400 grams of dehulled grain.

Some of the more recent introductions of naked oats have been grown for one or two years at the field stations of the Office of Cereal Investigations. At some stations they were so poor that they were not thought worth harvesting. As a consequence, few yield data on hull-less varieties have been accumulated. Such data are available for 1914 and 1915 at both Moccasin, Montana, and Highmore, South Dakota, on one variety of naked oats. At Moccasin, the hull-less averages 1,098 pounds to the acre, as against 1,802 pounds of Swedish Select oats. At Highmore, the average yield of the

* For numbered references, see *Literature Cited,* at end of article.

PANICLE AND SPIKELET OF CROSS-BRED NAKED OATS

FIGURE 16. This is one of the improved varieties of naked oats developed in Canada. Heavier yields are obtained than from Chinese naked oats (Figure 14), and it is more resistant to rust. Nevertheless it is not a very desirable proposition from the farmer's standpoint, as the amount of grain produced is less than that of any of the standard hulled varieties. It was developed by Dr. Saunders, of the Ottawa Experiment Station, by crossing Swedish Select (Figure 15), and Chinese Hull-less (Figure 14), and is called Liberty Hull-less. Many of the leading plant breeders have tried to produce a strain of naked oats that would be superior to the hulled varieties, but so far none of them has been successful.

hull-less variety was only 224 pounds compared with 1,792 pounds produced by the Sixty-Day.

During the years 1917, 1918 and 1921, three varieties of naked oats were included in the oat nursery maintained by the Office of Cereal Investigations on the Aberdeen Substation, Aberdeen, Idaho. The average yields of these varieties were 4,134, 4,370 and 4,458 pounds, as compared with an average yield of 6,742 pounds from the Silvermine oat under the same conditions. Reducing the latter yield by twenty-five per cent, the normal weight of the hulls, the Silvermine still produced 5,057 pounds of kernels with the hulls removed, considerably more than any of the naked varieties.

The Liberty Hull-less has been included in recent nursery experiments at Cornell University. Its average yield for the three-year period from 1919-1921, inclusive, has been 961 pounds as compared with 1,850 and 1,710 pounds for Cornellian and Silvermine, respectively, two of the best common varieties.

These figures show clearly that naked oats cannot compete with common hulled oats in yield, the most valuable asset of any crop variety. Naked oats cannot be recommended for growing under field conditions, and it simply is a waste of time and money for farmers to attempt to grow them. Not until better yielding naked varieties are developed will it be possible to make a recommendation favorable to this type of oats.

Other Undesirable Characters

Even if naked oats compared favorably with ordinary oats in yield, it is very doubtful if they would be grown extensively because of the poor keeping qualities of the grain. It is difficult to store them in bulk in large quantities, as they go out of condition very quickly. The absence of hulls apparently affects the process of respiration in the kernel, and as a result deterioration takes place rapidly. Naked oats also lose their viability in a short time, seed a year old usually showing a very low percentage of germination.

Inheritance of the Naked Character

Naked oats have some value for hybridization, though they are of more interest to the geneticist in determining the mode of inheritance of certain characters than they are to the practical plant breeder. Some of these studies have been reported.

Norton[8], Zinn and Surface[12], Gaines[2], Love and McRostie[5], and Capron[1], have reported on studies of the mode of inheritance of the naked character in naked-hulled croses. Their results agree quite well and indicate rather definitely a simple monohybrid segregation in the second generation of one naked, two intermediate (with both naked and hulled oats in the same spikelet), and one hulled.

The main object of practical breeders such as the Gartons[3, 7] of England and Pringle[9, 4, 11] of Vermont in using naked oats for crossing was to obtain a many-flowered hulled variety. The results of recent investigations, however, particularly the work of Zinn and Surface, Caporn, and Love and McRostie, indicate that such a variety is impossible. They have shown that the many-flowered spikelet and naked kernel or membraneous palea are linked. For this reason the number of flowers is reduced in all plants which breed true for adherent palea (hulled condition). According to Capron, a biflorous naked form is possible, but from the practical aspect is not desirable. On the other hand, a multiflorous hulled form is very desirable, but seems impossible genetically.

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Bringing Up the Baby

NURSERY GUIDE, by LOUIS W. SAUR, M. D., Senior Attending Pediatrician, Evanston Hospital. Illustrated with 11 figures. Pp. 188. Price, $1.75. The C. W. Mosby Co., St. Louis, 1923.

Of at least indirect interest to eugenists is the problem of raising children after they are born. As an aid to this, "Baby Books" are of no small value. Perhaps as more of them come into being, that much discussed quality, intelligence will be given a survival value by reason of the fact that only the exceptional mother will be able to unravel the meaning of some of the phrases used in them.

The most valuable innovation in this volume and one that is only inadequately used, is to illustrate the more complicated phases of "bringing up the baby" by means of photographs. However, even a beginning in this direction is to be commended, and we hope that the idea can be extended and amplified in later editions.

The book contains very few statements regarding heredity, but on the first page of the text is one that is certainly open to misinterpretation: "Tuberculosis is not inherited, but is acquired some time before or after birth."

As it stands, the statement is true, but it is misleading in that no mention is made of the important role of heredity in determining whether tuberculosis will or will not be acquired. Recent investigations indicate that this "indirect heredity" is all-important. We are all exposed to tuberculosis, but those individuals who have inherited a susceptibility to the disease are much more likely to fall victims to it than others living under similar conditions who come of resistant stock.

Eugenics in Germany

Privat-dozent Dr. Fritz Lenz, one of the editors of the Archiv fuer Rassen- und Gesellschaftsbiologie, has been appointed Professor of Race Hygiene (the German equivalent of eugenics) at the University of Munich. This is the first professorship in Germany to be devoted to eugenics under the name, although Heinrich Poll has for some years occupied a chair of "human genetics" at the University of Berlin.

WISCONSIN "EUGENICS LAW" NOT REPEALED

ACCORDING to a widely circulated report the so-called Wisconsin "Eugenics Law" has been repealed. As a matter of fact, this does not appear to be the case, although it is questionable whether keeping the law on the statute books has any great eugenic value. After considerable debate by the Wisconsin Legislature the old law was extended if not strengthened by adding a clause requiring women to file an affidavit that they are free from social diseases before a license to marry will be issued.

The original law was passed in 1914 and required "A medical examination of all male persons making application to marry." Later the courts ruled that it was not the intention of the Legislature to require the Wasserman test as part of the examination. This had the effect of further reducing the already limited usefulness oi the measure.

It is greatly to be deplored that such legislation should be connected in name with eugenics. The limited provisions of the law in the first place, and the way it has been administered show that it has little eugenic value. Perhaps the history of this law points a moral: that much research and a vast amount of education in the elementary principles of biological inheritance must come before sound legal action is possible and would receive the necessary public support. In a eugenically enlightened community with the importance of heredity properly appreciated, and the fact of the inheritance of many weaknesses both mental and physical generally realized, the right kind of pre-marriage examination would be of no small value. Until there is wide public appreciation of these facts it is impossible that many people would have the biological background to place the proper interpretation on the results of such an examination. The only effects that it has today are most certainly dysgenic. Serious-minded people, who appreciate their responsibility to future generations, are undoubtedly often deterred from marriage by such an examination, and for no sound biological reason. On the other hand, those who lack the mental capacity to realize the consequences of their acts are not led by it to forego marriage. Such a law must be backed by educated public opinion if its enforcement is to be either intelligent or effective.

The Mathematics of Life

MATHEMATIK UND BIOLOGIE, by MARTIN SCHIPS. Mathematical and Physical Library, Volume 42. Pp. 52; 16 figures. Price, 19 cents. Leipzig, Verlag von B. G. Tuebner, 1922.

This little booklet is not, as one might expect, a discussion of biometry, but rather an account of some of the mathematical relations existing within an individual living organism. The symmetry of organisms finds one of its most complicated illustrations in the arrangement of leaves on the stem of a plant, according to formulas which can be worked out definitely, and formed the basis, a score of years or so past, of a study that enjoyed some popularity, namely, phyllotaxy. The size-relations of an organism are also discussed under the head of morphology. The second part of the book is given up to anatomy and physiology. It considers such problems as the mechanics of bones, muscles, and blood vessels, and ends with a discussion of Weber's Law. While all these subjects are more or less familiar to the student, it is worth while to have them brought together and correlated; and the formulas which the book contains will also be found convenient for reference. —P. P.

A MULTIFLOROUS VARIATION IN BURT OATS

F. A. Coffman and K. S. Quisenberry[1]
U. S. Department of Agriculture.

A STUDY of variation in Burt oats[2] has been conducted during the past several years at the Akron Field Station of the United States Department of Agriculture at Akron, Colo., and at the Kansas Agricultural Experiment Station, Manhattan, Kans. In this study, a plant appeared in a strain of Burt, C. I. No. 1921,[3] grown at Akron in 1920, which showed the multiflorous spikelet correlated with the naked (hull-less) condition characteristic of *Avena nuda*. The outer glumes of the spikelets were long, resembling those of *Avena nuda*. The spikelets were from two to six flowered, with elongated rachillas, causing the florets to extend beyond the outer glumes.

The lemma and palea were of a dark brown color and the caryopsis [kernel] was larger than is common with the naked oats (Fig. 17). Approximately forty per cent of the seeds thrashed free from the flowering glumes. The percentage of naked seeds in the spikelet did not appear to vary with the position of the spikelet on the panicle. The panicle of the variation shown in comparison with ordinary hulled and naked oats in Figure 21 presented, in part, the appearance of a hulled × hull-less first generation hybrid as described by Norton (6),[4] Zinn and Surface (8), Gaines (2), Caporn (1), and Love and McRostie (4). Norton observed one plant resulting from the cross, European Hull-less × Garton's Tartar King, which he states "seems to have become fixed in the intermediate type. In this example we have an extremely rare case of the fixation of a heterozygote or hybrid state." Farther than this statement no information regarding this peculiar form seems to have been published. Hulled and naked kernels from panicles bearing naked seeds, hulled seeds from normal panicles and ordinary naked kernels are shown in Figures 19 and 20.

The particular strain of Burt oats in which this variation appeared originated at the Iowa Agricultural Experiment Station, Ames, Iowa. It was introduced into the agronomic nursery at the Kansas Agricultural Experiment Station, Manhattan, Kans., in 1918. So far as the history at the Kansas station is known, this selection had never been grown adjacent to or even near any *Avena nuda* types.

The kernel from which the plant under discussion was grown was described as being of the *sativa* type of

[1] This study has been conducted by F. A. Coffman, assistant agronomist, Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture, located at the Akron Field Station, Akron, Colo., by K. S. Quisenberry, working both at the Kansas Agricultural Experiment Station, Manhattan, Kans., and the West Virginia Agricultural Experiment Station, Morgantown, W. Va. The writers are indebted to Prof. John H. Parker, in charge of crop improvement at the Kansas Agricultural Experiment Station, and to C. W. Warburton, in charge of cereal agronomy experiments in the Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture, for many helpful suggestions and criticisms in the preparation of this paper.

[2] The study of variation in Burt oats has been conducted as a cooperative problem at the Akron Field Station, Akron, Colo., and the Kansas Agricultural Experiment Station, Manhattan, Kans.

[3] Cereal Investigations accession number.

[4] Figures in parenthesis refer to *Literature Cited*, at end of article.

NAKED OATS

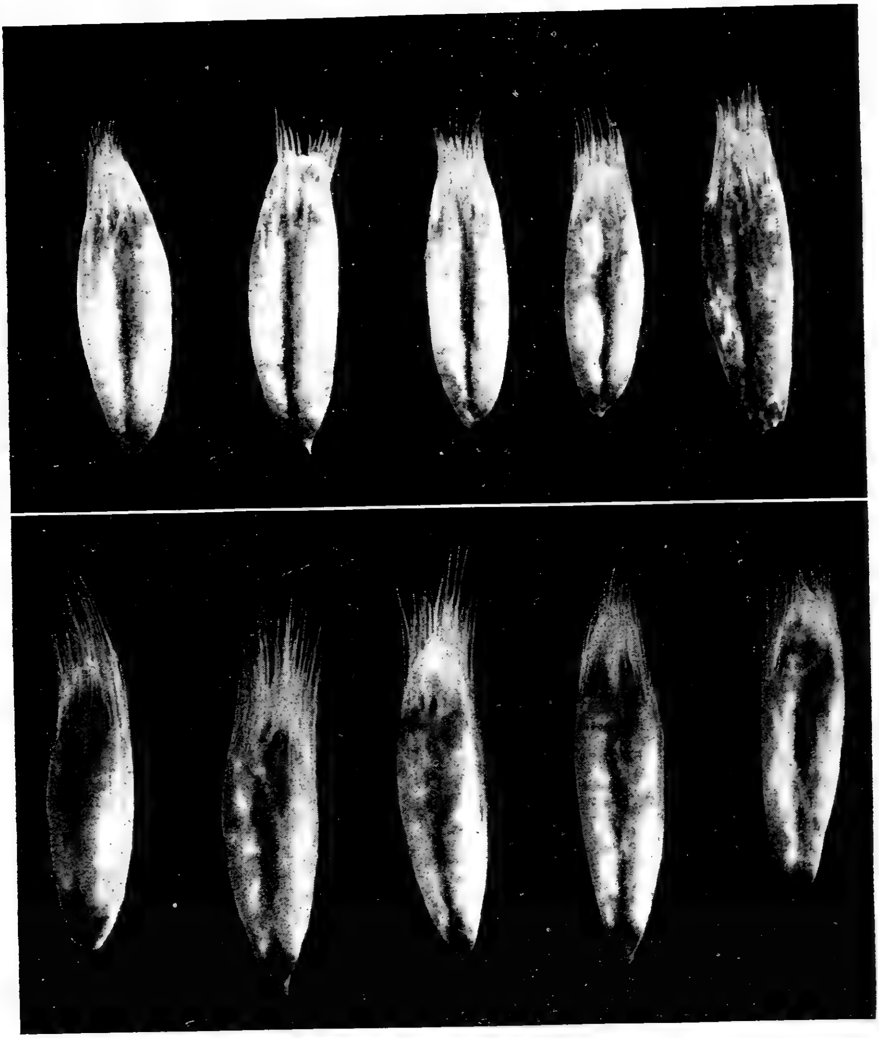
BURT OATS

NORMAL BURT OATS AND NAKED OATS

FIGURE 17. Normal hulled oats have only two flowers to the panicle, while naked oats have an average of seven. A strain of Burt Oats had been grown for several years at the Kansas Agricultural Experiment Station, when the variation shown in Figure 19 appeared in 1920. The selection in which the aberrant plant appeared had never been grown near any naked oats, so far as known. This, and the behavior of the plants in subsequent generations, makes the origin of the variation by natural crossing seem very unlikely.

THE MULTIFLOROUS VARIATION IN BURT OATS

FIGURE 18. Notice how much this form resembles naked oats except for the dark color of the spikelet, and the hardened glume tissue, which are not characteristic of *Avena nuda*. The multiflorous character would be very valuable to the breeder if it could be linked with the hulled condition. Unfortunately, even in this mutation the multiflorous spikelet and the hull-less kernels are found together, although in an intermediate form. The plants of this variation mature several days earlier than other varieties with which they were grown. No data has been obtained as to yield, in comparison with either hulled or naked oats.



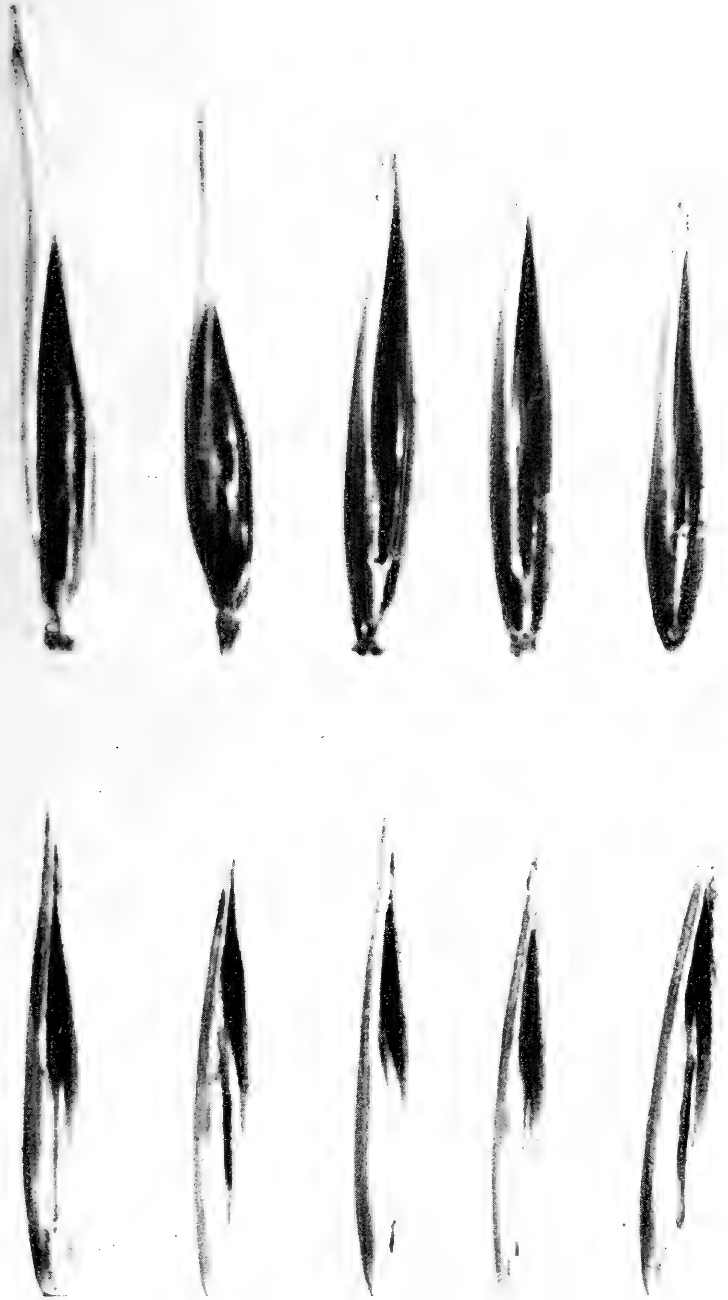
NAKED KERNELS OF BURT OATS AND HULL-LESS OATS

FIGURE 19. The grains of hull-less oats (top) are somewhat smaller and lighter in color than naked seeds of the Burt variation (bottom). The cause of the multiflorous variation is not known, but it appears to be due to a mutation rather than to natural crossing.

articulation, having no basal scar or basal pubescence. It had a brown glume and a weak awn. This kernel, along with several thousand others, was sown at Akron, Colo., April 29, 1920. The plant headed June 21, which was five days earlier than the average for the parent strain. Of 227 plants of this strain of Burt, but ten reached the heading stage before June 21. With the exception of the panicle, the characters of the plant did not vary greatly from the average of the parental strain.

Experimental Data

In 1921, kernels from the variant were sown at the Akron Field Station and at the Kansas Agricultural Experiment Station. Several unfavorable factors influenced the results obtained at the two stations. Weather conditions at Akron in 1921 were very adverse, and as a result of dry weather and the ravages of locusts but forty-three plants were grown to maturity from a total of eighty-one kernels sown. The plants at the Kansas station fared little better, injury by chinch



HULLED KERNELS OF BURT OATS

FIGURE 20. About forty per cent of the spikelets of the aberrant plants produce naked grains, the rest of the kernels being hulled like those shown above (top row). Both hulled and naked grains are found on different spikelets of the same plant. These grains of the multiflorous variation are darker and somewhat larger than the normal Burt oats (lower row)

bugs preventing all but sixteen plants from maturing seed. Although the 1921 experiments were affected by several unfavorable conditions, the results obtained were of a convincing nature. In all cases the plants grown at both stations presented an appearance closely approximating that of the original plant variant. Some plants resembled the characters of *Avena nuda* more closely than others, but no plants were found which resembled the hulled oat type to a very marked degree.

In 1922, kernels from each of the plants of the variant grown at the Akron station in 1921 were sown on April 27. A total of about two hundred kernels was sown, from which one hundred ninety-three plants grew to maturity. The plants were unusually early in heading and most of them had fully matured by July 16. It was found, on closely examining the panicles, that all but one of the plants presented the intermediate hulled-naked form of the original variation discovered in 1920. One plant bearing two small panicles was observed in the material grown at Akron in 1922, which bore only naked kernels. This plant closely resembles the other plants of this peculiar strain of Burt oats in all other respects, however, and does not appear to be a true *Avena nuda*. Whether it will reproduce this naked condition can be determined only by growing progeny from it.

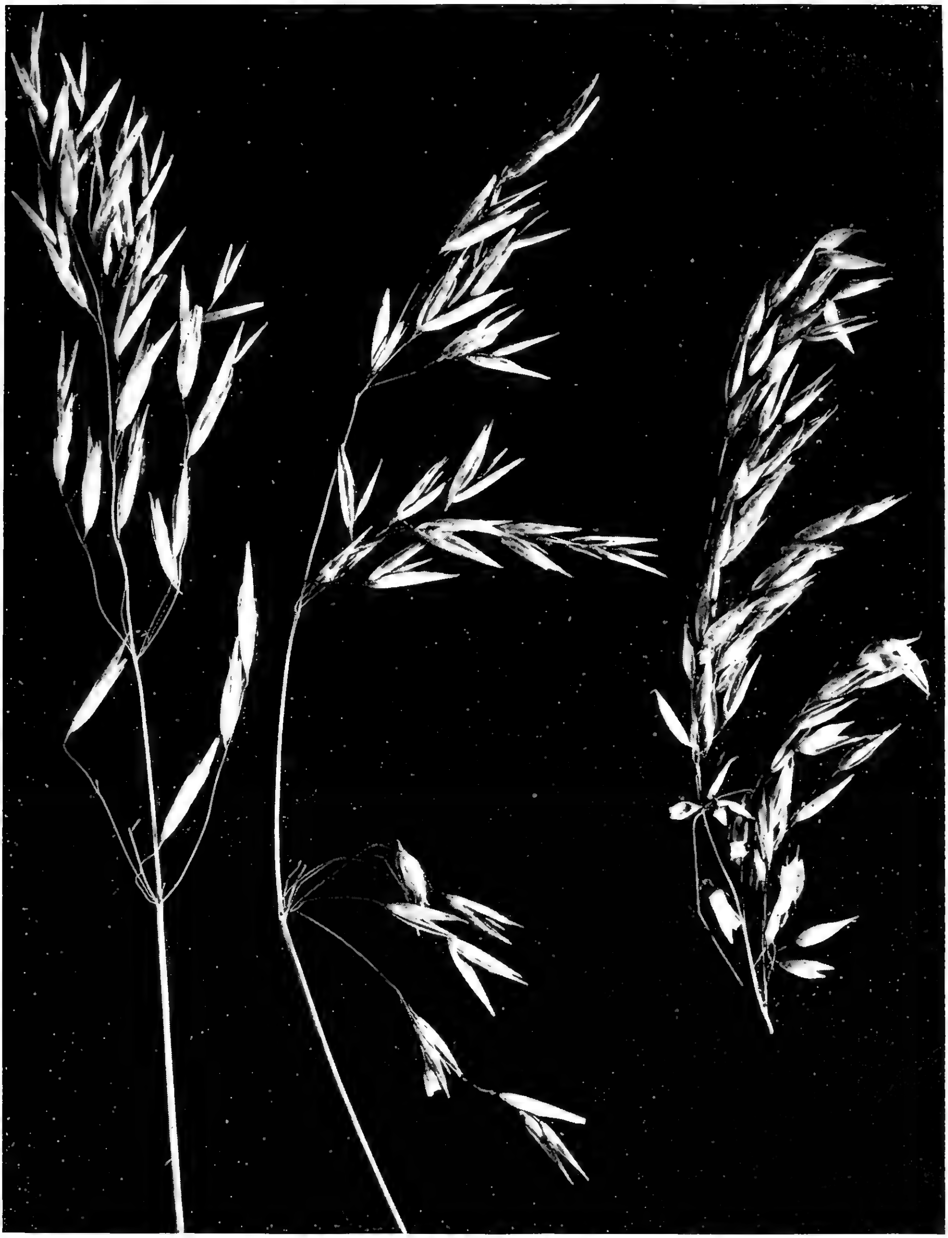
The weather at Akron, Colo., in 1922, was very dry during the time these plants were maturing, and as a result the color of the glumes of the oat kernels was perfectly developed. It was of interest to discover that in some panicles the glumes were very nearly black.

A total of 150 kernels of the variant was sown in the Plant Breeding Nursery at Morgantown, W. Va., in 1922. From these about one hundred plants developed. These plants were the earliest forms in the nursery, heading several days before any of the other oats. All of the plants again showed the intermediate form, characteristic of the original variant.

Discussion

The cause of this multiflorous variation in Burt oats is not definitely known. Natural crosses are known to occur in oats and have been reported by various plant breeders. For a natural cross to occur it would have been necessary for the Burt strain, C. I. No. 1921, to have been grown near a naked form, and so far as is known this did not occur at the Kansas Agricultural Experiment Station at Manhattan, Kans., in 1919, when the strain was grown at that station. If the variation was due to a cross, segregation such as has been reported by various plant breeders for hulled × naked crosses would be expected. During the three seasons this plant variant and progeny from it have been grown, segregation has been noticed in only one case, and this segregating plant more closely resembles the multiflorous variant from which it originated than it does the *Avena nuda* form. If this form originated from a hulled × naked cross, the progeny should, according to those who have investigated crosses between hulled and naked forms, have segregated into hulled, intermediate, and naked forms in the ratio of 1:2:1, in the 1921 crop. According to Gaines (2), the development of color is supposed to be inhibited by the naked character in segregates of hulled × naked crosses. Panicles in which the glume color is very well developed are not difficult to find in the plants of this variation and some plants which have almost black glumes have been observed.

Various mutations have been reported in oats, both in plant and seed characters. Nilsson-Ehle (5) noted the occurrence of white or gray individuals in black varieties. Warburton (7) found dwarf forms of plants appearing in the Victory variety. The seed from these dwarf forms, when planted, bred true. No explanation of



NAKED OATS AND BURT OATS

FIGURE 21. The multiflorous variation of Burt oats looks not unlike a first generation hybrid between hulled and naked oats, as described by other authors. However, its genetic behavior is entirely different. No segregation occurs in later generations, which would be expected if the form were a hybrid.

the occurrence of the dwarfs is given except that there was no evidence of hybridization. Love and McRostie (4) report forms similar to naked oats, which, they indicate, may have originated through mutative changes. In a pure line of Sixty-Day, spikelets appeared similar to true naked forms. The kernel was loosely held in the glumes and an increased number of flowers developed per spikelet. When sown, these seeds produced plants which did not reproduce this naked tendency. Garber (3) describes forms of false wild oats appearing in Victory, Garton No. 784, and Aurora, and states that "these aberrant forms may be attributed more logically to mutations than to natural crossing."

Summary

Numerous reports on controlled crosses of hulled × naked oats have been published. All of these reports have shown segregation in the second hybrid generation in the ratio of 1 hulled: 2 intermediate: 1 naked. A total of fifty-nine progeny plants of the variant multiflorous forms was grown in 1921, and 300 progeny plants were grown from these in 1922. Variation in the characters of the covered kernels of the progeny plants has been noticed, but as yet only one case of segregation of the plants into either the hulled or naked forms has occurred. The one apparent segregate was an under-developed individual and, except that it bore only naked kernels, closely resembled the other plants of the variant type.

It is difficult to explain the origin of the multiflorous variation in Burt oats on the basis of natural crossing, although natural crossing is believed to occur in oats to some extent. The genetic behavior of this variation is not in agreement with the results of those who have reported on crosses of hulled × naked oats. It appears, therefore, that this intermediate multiflorous variation may have resulted from mutation rather than by natural hybridization.

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CONTENTS

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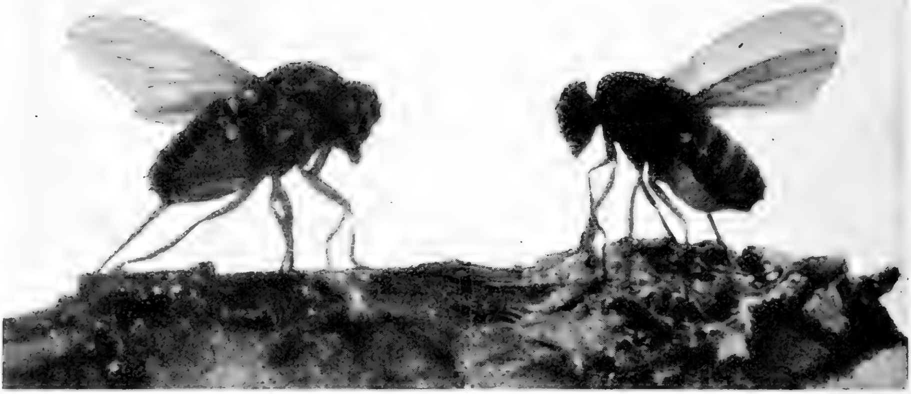


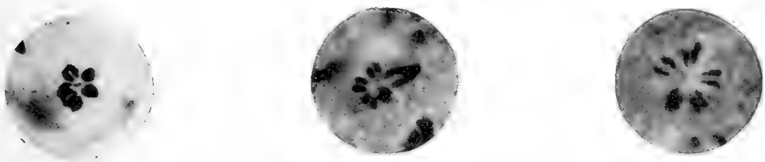
THE MULLER FRUIT FLY

More is known about the heredity of these tiny flies than of any other form of life. The ease and great rapidity with which many generations may be raised in the laboratory, and the small number of chromosomes found in the dividing cells of these flies makes them ideal subjects for studying the relation between the cell mechanism, as determined by cytologists, and the facts of heredity brought to light by genetic experiments. In this genus twelve different chromosome "patterns" are found (see Figure 2), and the attempt is now being made to discover by genetic experiments how some of these twelve types of chromosomes are related to each other. The individuality of the chromosomes within the species is well proven, and if homologies can be established between the genetic structure of these carriers of heredity in several distinct species, light will be thrown on the evolution of the chromosomes. The photographs shown above are of *Drosophila mulleri*, greatly enlarged. This species is nearly identical in external appearance with two others, *repleta* and *hydei*. In fact, no distinction was made between the three until it was found that they would not cross. Their chromosomes proved to be unlike, and minor external differences were later discovered. Photographs by Robert C. Cook. (Frontispiece.)

CHROMOSOMES OF DROSOPHILA

Chromosome Relationships and Genetic Behavior in the Genus Drosophila: I. A Comparison of the Chromosomes of Different Species of Drosophila

Charles W. Metz and Mildred S. Moses
Carnegie Institution of Washington, Department of Genetics



THE CARRIERS OF HEREDITY IN DROSOPHILA

Figure 1. Photographs of chromosome groups of three species of Drosophila, magnified about 1,000 diameters. The heavily stained bodies are the chromosomes, which in these flies are arranged in pairs with almost diagrammatic precision. These minute objects play the principal role in inheritance. The figures are from ovarian cells of *Drosophila virilis* (left), *Drosophila funebris* (middle), and *Drosophila ramsdeni* (right). The photographs were made from our preparations by Professor E. B. Wilson and were used by him in the Croonian Lecture of 1914, but have not been published heretofore. They are reproduced here with his kind permission.

OWING to the ease with which many species of Drosophila may be bred in the laboratory and to the fact that a wide range of chromosome groups is represented within the genus, species of this group have come to be used extensively for comparative genetical studies. The purpose of such studies is two-fold. In the first place it is desired to ascertain to what extent different species will give rise to similar mutations and whether or not similar mutant characters are inherited in a corresponding manner in the different species. In the second place it is desired to analyze the genetic make-up of the chromosomes in different species by means of linkage studies, and on the basis of such analyses to compare the chromosomes of the different species with respect to their genetic composition. In this way it may be possible to correlate the genetic structure, so to speak, of the chromosomes, with their morphological appearance, and thus to learn something of the evolution of the chromosomes.

It is our purpose to review in the present and a later paper the results obtained up to the present time. Since the selection of species for genetical study has been based, to a certain extent, upon their chromosomal relations the latter may be considered first. The present paper, therefore, deals with the cytological evidence, leaving the genetical aspects to be considered later.

In reviewing the cytological data, all of the species of Drosophila and related genera, whose chromosomes have been studied, will be included. These, of course, represent only a fraction of the known species, especially in the genus Drosophila. The descriptions are taken in large part from the previous papers, but they also include a considerable amount of new data. In presenting the data an effort has been made so to arrange them that they will

serve not only for the present purpose but also for ready reference in the future.

Description of Different Types of Chromosome Groups in the Drosophilinae

The principal known types of chromosome groups in the Drosophilinae have been described and figured in earlier papers,* [2, 3, 4, 5,] but more recent observations necessitate several corrections and changes, as well as additions to the earlier lists. It is also possible now to attach the proper specific names to some of the species not identified before, for Sturtevant has recently published a full taxonomic account of the group.[9]†

The material upon which cytological studies have been made includes twenty-seven species of Drosophila, two of Chymomyza, two of Scaptomyza, one of Mycodrosophila and one of Cladochaeta—thirty-three in all. Among these species thirteen types of chromosome groups have been found as shown diagramatically in Figure 2. All of these but one (type H) are found within the genus Drosophila. It should be stated at the outset that our cytological knowledge of some of these species is not extensive, and minor modifications may be found to separate the chromosome groups of some species now put under one type; but we believe that in all of the species included here the chromosome groups are essentially as given.

The Diptera are particularly favorable for a comparative study of this kind because of the fact that the chromosomes are arranged in pairs in an almost diagrammatic fashion in the diploid cells, somatic as well as germinal. In other words, homologous chromosomes tend to associate and remain associated throughout development. This association is indicated by the camera lucida drawings published in earlier papers (l. c.) and by the accompanying photographs (Figure 1).‡ The diagrammatic representations in Figures 2 and 4, therefore, are not as highly schematized as might be imagined. In most respects they resemble the actual figures seen under the microscope.

The thirteen types of chromosome groups (Figure 2) are not equally common among the species studied, but are for the most part represented by only one species each, with the bulk of the species falling under three main types. The distribution is indicated in the following list.

List of Species Arranged According to Chromosome Resemblance

In this list the names in parenthesis are those given in the list published in 1916[5] and subsequently changed. We are indebted to Dr. A. H. Sturtevant for the specific determination in most cases.

Type A

Drosophila busckii Coq.
D. bromeliae Sturt.
D. florae Sturt.
D. melanogaster Meig. (*ampelophila*)§
D. nebulosa Sturt. (*limbata*)
D. quinaria Loew.
D. robusta Sturt.
D. saltans Sturt.
D. simulans Sturt. (not in earlier list)
Chymomyza amoena Loew. (*Drosophila amoena*)
Chymomyza procnemis Will. (*Drosophila procnemis*)
Mycodrosophila dimidiata Loew. (*Drosophila dimidiata*)
Scaptomyza graminum Fall.

Type B

D. earlei Sturt.

Type C

D. calloptera Schin. (*ornatipennis*)
Scaptomyza adusta Loew.

Type D

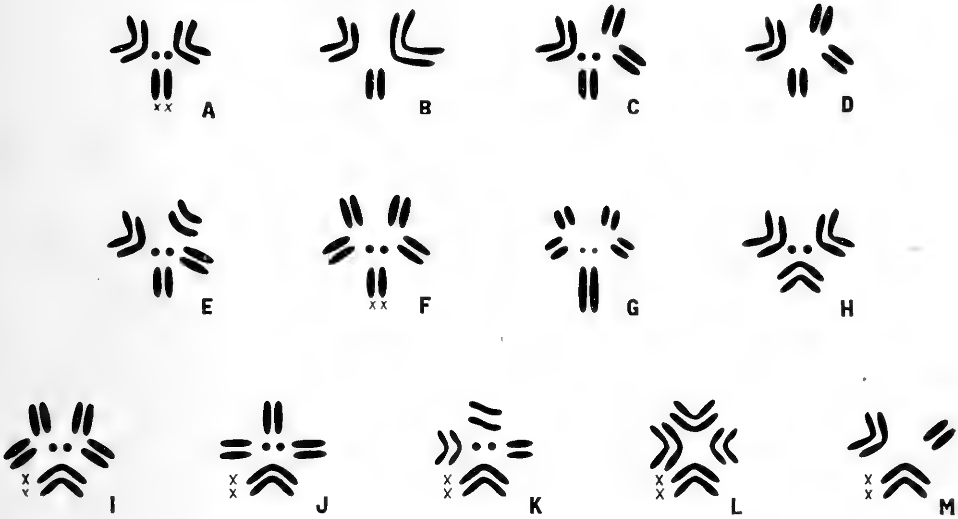
D. immigrans Sturt. (*tripunctata*)

*For Numbered References, see "Literature Cited" at end of article.

†The chromosomal characteristics are briefly reviewed in this also.

‡The drawings in Figure 3 of the present paper are from smear preparations in which the cells have been flattened and the chromosomes disarranged somewhat, hence the pairing is not so obvious.

§Names in parenthesis are those given in previous list (Metz '16b), and subsequently changed.



CHROMOSOME PATTERNS IN DROSOPHILA

FIGURE 2. Diagrams of the known types of chromosome groups in the Drosophilinae. All but Type H are found within the genus Drosophila. XX indicates sex-chromosomes. Notice the similarity between Types A, B, and M. Types A and M were confused for a time, as the absence of the dot-like chromosome may be contributed to faulty staining technique. Later it was found that the sex-chromosomes were V-shaped in M instead of rod-like as in A. The great majority of species belong in Type A or Type F.

Note: We are indebted to Miss E. M. Lord for making the drawings used in this article.

TYPE E

D. melanica Sturt.

TYPE F

D. cardini Sturt.
D. ramsdeni Sturt.
D. mulleri Sturt. (*repleta* variety a)
D. similis Will.
D. tripunctata Loew. (*modesta*)
D. virilis Sturt.
D. species? (European, resembles *D. obscura;* not in previous list)

TYPE G

D. funebris Fabr.

TYPE H

Gladochaeta nebulosa Coq.

TYPE I

D. repleta Woll. (*repleta* variety b).
D. hydei Sturt.

TYPE J

D. obscura Fall. (Oregon)

TYPE K

D. affinis Sturt.

TYPE L

D. caribbea Sturt.

TYPE M

D. willistoni Sturt. (*pallida*)

The Sex-Chromosomes

The diagrams in Figure 2 are based on the chromosome groups of the females. The sex-chromosomes here are represented by the lowermost pair of the group and are marked XX wherever they have been identified; but they have not been identified in all cases. One reason for this is that some of the species do not exhibit a conspicuous dimorphism between the X and Y chromosomes in the male (which is the criterion usually used for identification). In addition it is usually more difficult to obtain figures of the male groups than of the female groups in this material, particularly from adult flies, and consequently we lack male figures of some of the less common or less easily reared species.

The present section includes the known evidence on the sex-chromosomes and also a statement indicating where the evidence is doubtful and where it is lacking.

Sex-Chromosomes Identified

In the following species the sex-chromosomes have been identified in the manner indicated:

Type A. *Drosophila melanogaster* — dimorphism of X and Y, and non-disjunction 7, 1; X rod-like, Y hook-shaped.

Type I. *Drosophila repleta*—dimorphism of X and Y; X long V-shaped, Y only half as long and rod-like.[5]

Type J. *Drosophila obscura* (Oregon)—X and Y as in *D. repleta*.[5]

Type K. *Drosophila affinis*—as above.[5]

Type L. *Drosophila caribbea*—as above.[5]

Type M. *Drosophila willistoni*—identified by means of non-disjunction; X and Y both long and V-shaped (Lancefield and Metz);[2] also show aberrant behavior in first spermatocyte division (unpublished data).

Sex-Chromosomes Doubtful

In a few cases our slides show indications of a sex-chromosome dimorphism, but we have insufficient material to be conclusive. These cases are as follows:

Type A. *Chymomyza amoena. Scaptomyza graminum.* In both of these it is the rod-like pair which appears in some figures to be dimorphic; but in other figures all of the pairs appear to be symmetrical, suggesting that the apparent dimorphism in the former is accidental.

Type C. *Scaptomyza adusta.* One rod-like pair appears slightly dimorphic in some figures, and appears to be aberrant in behavior in first spermatocytes.

In the case of Type F no serious problem is presented, for it seems practically certain that the dot-like chromosomes are not the sex-chromosomes and hence any one of the rod-like pairs may be assumed to be the sex-chromosomes. This is indicated alike by cytological evidence and by genetical evidence in the case of *Drosophila virilis* (to be considered later).

There remains only the species in which X and Y have not been identified, but are known to be similar, and those on which there is no evidence.

Sex-Chromosomes Apparently Similar in Male

Type A

D. busckii
D. bromeliae
D. robusta
D. simulans

Type E

D. melanica

Type F

D. virilis
D. species? (European, resembles *D. obscura*)

Type G

D. funebris

Type M

D. willistoni (see under first heading).

Chromosomes of Males Not Examined, or Evidence Not Satisfactory

Type A

D. florae
D. nebulosa
D. quinaria
D. saltans
Chymomyza procnemis
Mycodrosophila dimidiata

Type B

D. earlei

Type C

*D. caloptera**

Type D

D. immigrans

Type F

D. cardini
D. mulleri
D. ramsdeni
D. similis
D. tripunctata

Type H

Cladochaeta nebulosa

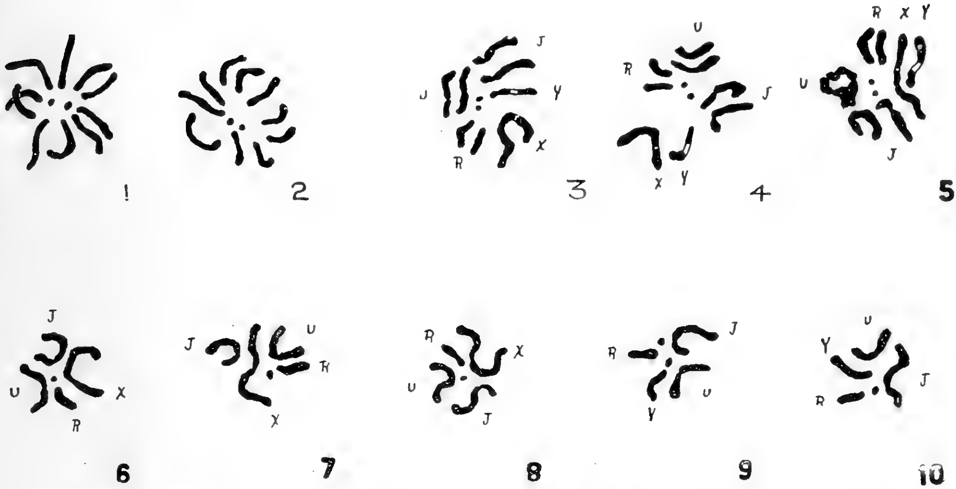
Type I

D. hydei.

In considering the relationships of the types outlined above it is necessary to take account of the sex-chromosome characteristics wherever possible. This necessity has recently been brought out in the case of *D. willistoni,* which was formerly included under Type A,† where the sex-chromosomes of the species used as a standard for the type (*D. melanogaster*) are rod-like. It

* In an earlier paper[5], this species (called *ornatipennis*) was erroneously said to have dimorphic sex-chromosomes.

†At that time it was not known that *willistoni* probably lacked the small dot-like pair, for only a few figures had been examined and the absence of this pair was thought to be due, possibly, to over extraction or to displacement. It will be noted that the *willistoni* group also resembles Type B, but in the latter, one V-chromosome pair is much larger than the other and the types are separated on this account.



CHROMOSOMES OF D. AFFINIS AND AN UNNAMED EUROPEAN SPECIES

FIGURE 3. Camera lucida drawings of chromosome groups from aceto-carmine "smear" preparations. Numbers 1 and 2 are from an undescribed European species of Drosophila very much life *D. obscura*. They are metaphases of spermatogonial cells and represent Type F. Numbers 3 to 10 are from *D. affinis* (Type K). 3 to 5 are from spermatogonial cells and include the full species number of chromosomes, arranged in pairs. 6 to 10 are from the second spermatocytes (which develop into spermatozoa). They include only the haploid number of chromosomes—one member from each pair. 6 to 8 represent the X-containing (or female producing) class; 9 and 10 represent the corresponding Y-containing (male producing) class. Each chromosome has its characteristic shape and size. In addition to the small dot-like chromosome (not lettered) there are the sex-chromosomes (X and Y), the small rod-like chromosomes (r), the small U- or V-shaped chromosomes (U), and the J-shaped chromosomes (J). In number 9 there appear to be two of the small m-chromosomes present, but one of these may be a granule accidentally carried into the middle of the field.

was assumed that in *willistoni* also the rod-like pair was the sex-chromosome pair, but this is not the case. By means of non-disjunction it has been shown that one of the large V-shaped pairs is the sex-chromosome pair.[2] Consequently *willistoni* has been put in a new type (M). This suggests that other species included under Type A may also possess V-shaped sex-chromosomes. And it indicates that in comparing types in which the sex chromosomes are not known it is unsafe to assume a correspondence to types in which they are known merely on the basis of general similarities between the groups.

Characteristics of Individual Chromosomes

When the individual chromosomes of the different types are compared it is seen that for the most part they fall into three main categories distinguished by size, form, and behavior. These have been described in detail in earlier papers and need only a brief characterization here, as follows:

1. *The large V-shaped chromosomes*, with median constriction and median spindle fibre attachment; oriented in metaphase with the apex of the V toward the center of the figure.

2. *The rod-like chromosomes*, approximately half the length of the V's; straight, without median constriction; with terminal spindle fiber attachment and radial arrangement in metaphase.

3. *The m-chromosomes*, small, dot-like micro-chromosomes, almost invariably in the center of the field during metaphase.

Only two of the thirteen types of groups include chromosomes that do not come under the above headings. These are types E and K. In E

there appears to be a very small V- or U-shaped chromosome pair, more or less intermediate between the rod-like and the large V-shaped kinds. Only one representative of this type is known (*D. melanica*), but we have numerous good figures of both male and female groups, including haploid (male) groups, and are able to distinguish the small U-shaped pair in nearly every case.

In type K two pairs are found which are intermediate between the V's and the rods in length. One has a subterminal spindle fibre attachment giving it an S or a hook shape. The other has a median or sub-median attachment and is much like the small V- or U-shaped pair just described in *D. melanica*. In some figures both of these pairs are somewhat S-shaped, and were so indicated in previous papers. But we have recently put up new material and have examined a series of figures which have convinced us that one pair is really different from the other. Some of these figures are represented in the accompanying camera lucida drawings (Figure 3, Nos. 3-10) taken from spermatogonia and second spermatocytes. The letters indicate respectively the X and Y (sex) chromosomes, the small rods (r), the small U- or V- shaped chromosomes (U) and the J-shaped chromosomes (J). Numbers 3, 4 and 5 are diploid groups* from spermatogonia. Numbers 6, 7 and 8 are the X-containing haploid groups of the second spermatocytes, and 9 and 10 are the corresponding Y-containing groups. In Number 9, there appear to be two m-chromosomes present, but one of these may be a granule accidently carried into the middle of the field.

Cases of what appear to be simply modifications of the V's, rods or M's are seen in types B, G, and L. In Type B one pair of V's is unusually long; in Type G one pair of rods is unusually long and the other four are unusually short, while the M's are exceptionally small (compare with Type F); and in Type L one pair of V's appears to be smaller than usual.† Otherwise the types are distinguished merely by possessing different combinations of the three main sorts of chromosomes, except where distinctions are based on sex-chromosome differences, as discussed above.

Possible Relationships Between Different Types of Chromosome Groups

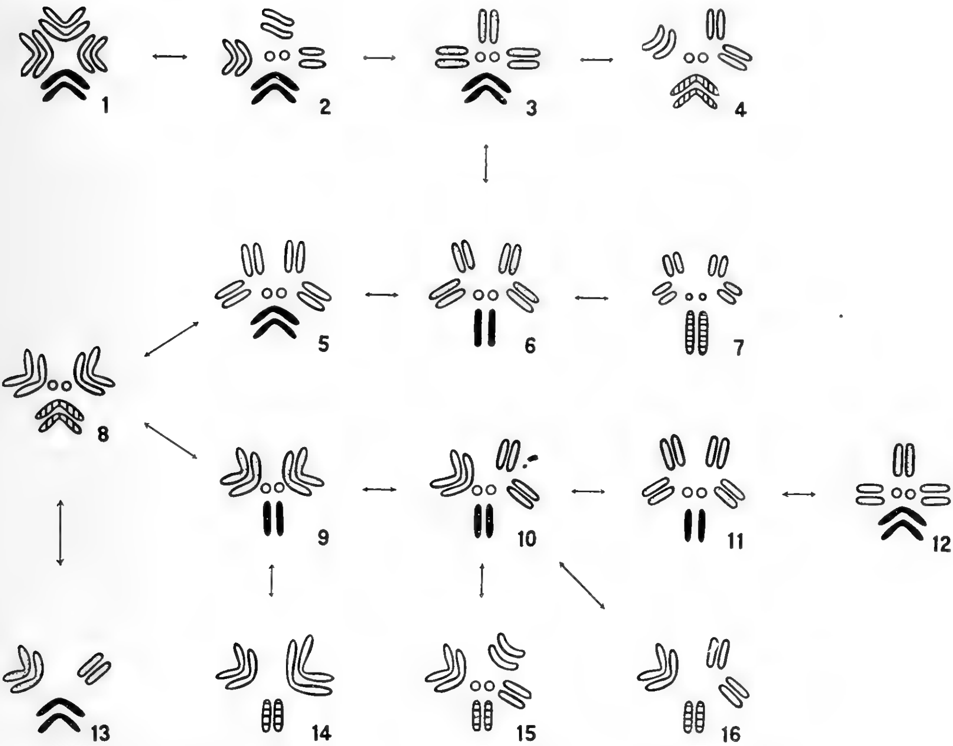
One of the most striking facts about the series of types is that many of them show such resemblances to one another that in some cases graded series may be arranged between widely divergent types. This suggests that the relationships are not purely fortuitous. It remains for genetical studies to establish these relationships, if they actually exist, but some of the possibilities suggested by the cytological findings may be outlined here.

These are represented schematically in Figure 4. In presenting this series of diagrams we wish to emphasize the fact that the arrangement is based purely on the superficial appearance of *types* and is not intended to indicate relationship between the particular *species* involved. Furthermore, it represents only one of various schemes that could be employed. It is given rather to present the problem than to indicate its solution.

In the diagrams the lowermost pair of chromosomes in each group is intended to represent the sex-chromosomes. Those given in solid black are known to be, or are believed on good evidence to be, the sex-chromosomes. The heavily banded ones are merely assumed to be the sex-chromosomes in

* In these, X and Y appear to be correspondingly segmented, as indicated by the clear band across each. This segmentation is distinct from the constriction at the point of spindle fibre attachment and its significance is not known. It seldom, if ever, appears in the second spermatocyte figures, and is presumably evident in the spermatogonia only in smear preparations.

† Perhaps this should be classed with the U-chromosomes of Types E and K, but it seems to be nearer the large V's in size.



POSSIBLE RELATIONSHIP OF THE VARIOUS CHROMOSOME GROUPS

FIGURE 4. This chart is intended only to show how the various groups may be arranged into a graded series, with the assumption of a few comparatively simple changes. These are fusion of two of the rod-like chromosomes to form a V, or vice versa, the loss of the m-pair, and changes in the size of other pairs. In order to determine whether this or any other arrangement represents the true condition, it would be necessary to study these relationships genetically. Note the similarity between the most common types shown here at 6 and 9. If the V's of number 9 were broken into rods the two types would be alike. Solid black chromosomes are known to be, or are believed on good evidence to be, the sex-chromosomes; the heavily barred ones are considered to be the sex-chromosomes in making up the series, but cytological evidence with regard to this is lacking. The stippled chromosomes indicate the types in which genetical studies are now under way that are expected to throw light on the homology of the chromosomes in the various groups.

placing the types as shown. Some types may be put in different places in the series according to whether one or another pair is assumed to be the sex-chromosome pair. This is only done in one case here, however (diagrams 4 and 15). Diagram 1 in this figure represents the most aberrant type thus far observed and is included merely for the sake of completeness. It has been found in only one species. The other types show more resemblances to one another and may be arranged in such a way as to make successive differences relatively slight. In the arrangement given here, for example, all of the differences might be accounted for on the assumption of a few comparatively simple changes. These would involve mainly the fusion of rod-like chromosomes in two's, end to end, to form V's or, *vice versa,* the breaking in two of V's to form rods, together with alterations in the size of individual pairs (particularly the m-pair) and in the form of certain pairs. The series included in diagrams 3, 6, 5, 8, 9, 10, 11 and 12 (duplicate of 3)

involves only the fusion of rods or the breaking of V's, except in the steps between 5 and 6 and between 8 and 9, where the change from a single rod to a V (or *vice versa*) is represented. The latter would involve the doubling in size of a chromosome or the diminution of a chromosome by half.

The steps involved in the other parts of the series are evident from the diagrams. One of them (10-16) involves merely the disappearance of the m-pair; another (9-14) the disappearance of this pair and the increase in size of one of the V-pairs. Diagrams 13 and 14 might equally well be put in other positions—as is true also in the case of certain others—but this would merely serve to complicate the figure.

From the standpoint of chromosome evolution several questions arise from a consideration of the above series. Foremost, perhaps, is the question as to how far morphological criteria may be relied upon as indications of genetic homology of chromosomes. This has already been answered partially, as noted above, by the observations on *Drosophila willistoni*[2] which show that in two out of three cases, at least, similar pairs are not strictly homologous when this species is compared with *D. melanogaster*[6]. However, it is possible, perhaps, to avoid the conclusion that would seem to follow from this if, as suggested above, we assume that V-chromosomes may break in two to form rods, and rods may unite to form V's. On this assumption we might start, for example, with type F and make up types A and M (the two just considered) in different ways depending on what particular rods we combined to make V's. The homologies of the rods might remain, but the resulting V's as units might not be homologous. In this case the actual relations could only be determined by genetical analysis of the chromosomes. This is one of the problems with which the actual genetical studies are concerned.

If chromosomes persist intact as hypothecated above the most definite relation between the appearance and the genetical make-up should be found in the case of the small m-chromosomes. This pair of chromosomes is present throughout almost the whole series of types, with surprising constancy of size, form and behavior. Morphological evidence is all in favor of the assumption of homology here, but again it remains for genetical evidence to furnish the proof.

Chromosome Resemblances and Taxonomic Relationships

Another question that presents itself is: What is the relation between chromosome resemblances and taxonomic affinity of the species involved in this study?

In general it is very difficult to determine the detailed taxonomic relationships within the genus Drosophila —partly because of the difficulty of deciding upon the relative importance of the various diagnostic characters. After mentioning a few aberrant forms (only one of which is included in the present paper) Sturtevant[9] (p. 70) concluded respecting the bulk of the species: "I have been unable to even make a satisfactory arbitrary division of them into groups."

In a few cases, however, two or three species show such close resemblances as to leave little question as to their taxonomic affinity, and it is of interest to note the chromosome relationships in these instances. One such case is that of *D. melanogaster* and *D. simulans,* in which the species are almost identical and may be hybridized[8]. Both of the species belong to type A with respect to their chromosomes. It has not been definitely established as yet that the rod-like chromosomes are the sex-chromosomes in *D. simulans,* but it seems safe to conclude tentatively that they are.

Another case of close resemblance is that shown by *D. repleta* and *D. mulleri.* Indeed, stocks of these species were reared in the laboratory under the same name (*repleta*) until it

CHROMOSOME DIFFERENCES IN SIMILAR SPECIES

FIGURE 5. The chromosomes of *D. mulleri* are of the F type, those of *repleta* (right) are of the I type, which differs from "F" only in having the X-chromosomes large and V-shaped instead of rod-like. Externally the two species look very much alike, and no differences were noticed until it was found that they did not hybridize. The close relationship of the two seems certain.

Figure 6. *D. obscura* has chromosomes of type J, while a similar European species has chromosomes of type F. Here the differences involve not only the sex chromosomes, but at least one pair of the others as well, for there are only five pairs in type J, and six in type F. These species do not hybridize in spite of their similarity.

was found that they differed in their chromosomes and that they would not hybridize. Subsequently they were differentiated by several external characters also, but their close relationship seems certain. One of these species (*mulleri*) possesses chromosomes of type F (one of the most common types); the other (*repleta*) is a representative of type I—which differs from F in that the X-chromosomes are long and V-shaped instead of rod-like. These relations are shown in Figure 5. Since the remainder of the chromosome group appears to be identical in the two species it might be inferred that at some time a decided change has occurred in the sex-chromosomes without visibly affecting the autosomes. If the change were from type I to type F it would seem to involve the loss of half of the X-chromosome, without necessarily affecting the Y. If it were in the opposite direction it would seem to involve the doubling of the X-chromosome.

It is of interest to note that the latter type of change has actually been observed in a mutant race of *Drosophila melanogaster* (by L. V. Morgan).[6] Here one rod-like X-chromosome has doubled leaving the two daughter elements connected end to end. This case may not have any significance in the present connection, for both sexes are asymmetrical in respect to their sex-chromosomes and half of the offspring die; but it at least demonstrates that chromosomes may become doubled and remain so.

A third example of closely related species is furnished by an American race of *Drosophila obscura* and European material of a very similar species which fails to hybridize with it.* *Drosophila obscura,* as noted above, has chromosomes of type J, while the European form falls under type F. Its chromosomes have not heretofore been described, hence we include two camera lucida drawings of spermatogonial groups in Figure 3 (Nos. 1 and 2). In both of these forms numerous good chromosome figures have been obtained and we feel confident of the accuracy of the observations. The difference here again involves the sex-chromosomes, but it also includes one pair of autosomes, as shown in Figure 6, for in F there are five pairs of autosomes and in J only four. The four are duplicated in F, but an additional rod-like pair is left over. When only the female groups are considered it might be imagined that the two X's of type J represent the two X's of F with a pair of autosomes attached at their ends; but when the male figures are reckoned with, the matter is more complicated and involves either the loss (actual or apparent) or the

* We are indebted to Dr. A. H. Sturtevant for a stock of the latter and for information about its behavior.

addition of a chromosome as large as the Y or one of the rods.

It is hardly profitable to speculate further on what has happened in the two cases just cited until genetical evidence is available, for as far as we can see, only breeding experiments will lead to the solution of the problem.

No experiments involving exactly this situation are being carried out at present, so far as we know, but there are others in progress which are sufficiently similar to give promise of suggesting the answer. In Figure 4 certain of the diagrams are emphasized by stippling. These are the types now involved in genetical studies. They include two of the types just considered—F and J. And they also include types A and M, which likewise involve differences in the sex-chromosomes. In neither of these cases are the two species concerned very close relatives, but if chromosomal homologies can be established in these cases, as seems possible from present indications, the interpretations thus provided may be applicable to other cases as well.

The above questions serve to illustrate some of the features which genetical studies are designed to clear up. A more detailed discussion will be given in connection with the genetical data.

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COLOR FACTORS IN BEAN HYBRIDS

KARL SAX

Maine Agricultural Experiment Station

And

H. C. MCPHEE

Bussey Institution of Harvard University

THE GENETIC results of bean breeding experiments which have been carried on at the Maine Agricultural Experiment Station for the past ten years are, in most cases, in accord with the results of previous investigators. Pigmentation of seed coat is dependent on a factor P, the recessive of which results in white beans. Mottling has been attributed to two factors in the same linkage group, both of which are necessary to produce mottling. Either mottling factor may exist independently in uniformly pigmented beans and when brought together by such parents result in mottled beans which do not breed true. However, some rather unusual results have been obtained with eyed beans.

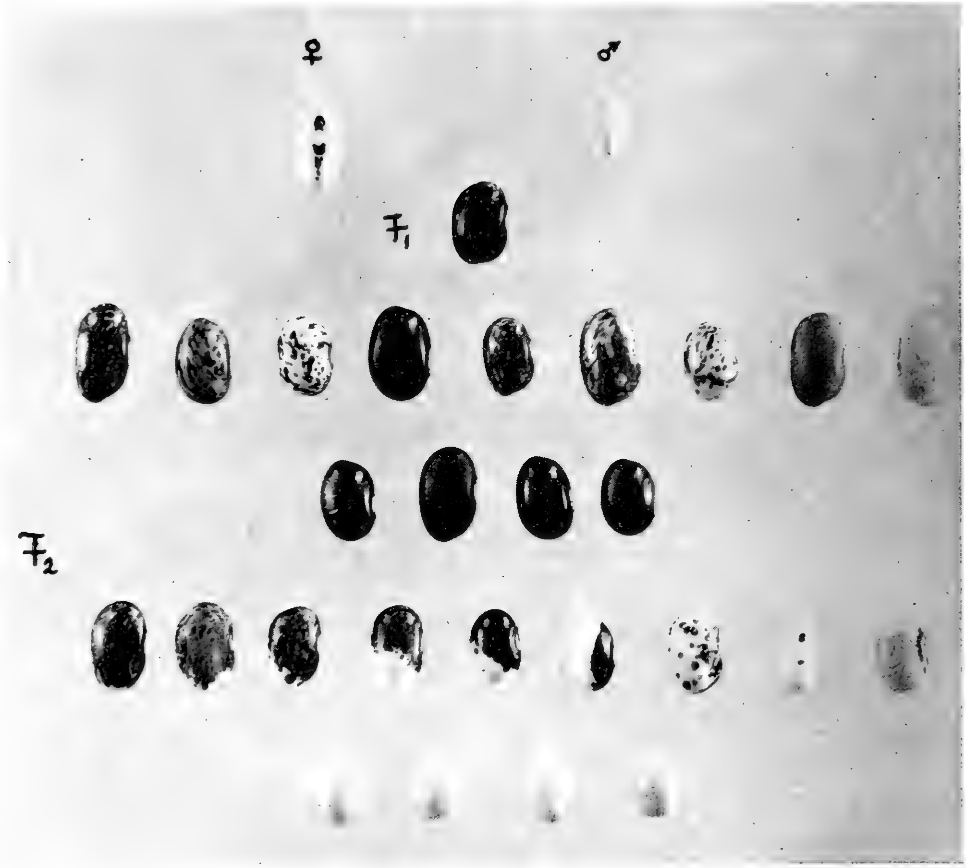
The behavior of certain crosses of eyed beans is of considerable interest in regard to allelomorphic relationships. The parents used are known under the rather local names of Old Fashioned Yellow Eye (*O. F. Y. E.*) and Improved Yellow Eye (*I. Y. E.*) The type of eye pattern of each variety is well illustrated in Figure 8. In the *O. F. Y. E.* the pigmented area covers about one-sixth of the surface of the seed, while in the *I. Y. E.* about one-fourth of the bean is pigmented.

The cross *O. F. Y. E.* × *I. Y. E.* results in "Piebald" beans in the first generation which have over twice as much pigmented surface as is found in either parent. This type of eye is irregular in outline and is accompanied by circular areas of pigment on the side of the bean opposite the hilum. In the second generation the segregation is 1 *O. F. Y. E.*: 2 "piebald": 1 *I. Y. E.*, indicating that only a single pair of allelomorphic factors are involved. The actual second generation segregates gave approximately 1:2:1 ratios, but in order to get larger numbers the second generation "piebald" beans were carried to the third generation. The behavior of these third generation segregates is shown in Table 1.

Each second generation "piebald" segregate was planted separately and in every case their progeny in the third hybrid generation segregated into *I. Y. E.*, *O. F. Y. E.*, and "piebald." The numbers of segregates in each class is a very good fit for a 1:2:1 ratio as indicated by the probable errors. The test for goodness of fit gave a value of $P = .8$.

The "piebald" character is rather variable, but seeds from the same plant are just as variable in pattern as seeds from different plants. In some cases the pigment is extended over almost the entire bean so that less than ten per cent of the seed coat is white. In no case did the piebald segregates breed true. The eye pattern of the eyed segregates varied somewhat in the second and third generations, but there was no difficulty in classing the segregates as *O. F. Y. E.* or *I. Y. E.* Over 300 such parental segregates were planted and not one failed to breed true.

It is evident that only a single pair of allelomorphic factors are involved in this cross. When these factors are in the heterozygous condition the pigmented area is more than doubled as compared with the parents and the eye pattern is not intermediate nor does it resemble the pattern of either parent. Usually a single pair of allelomorphic



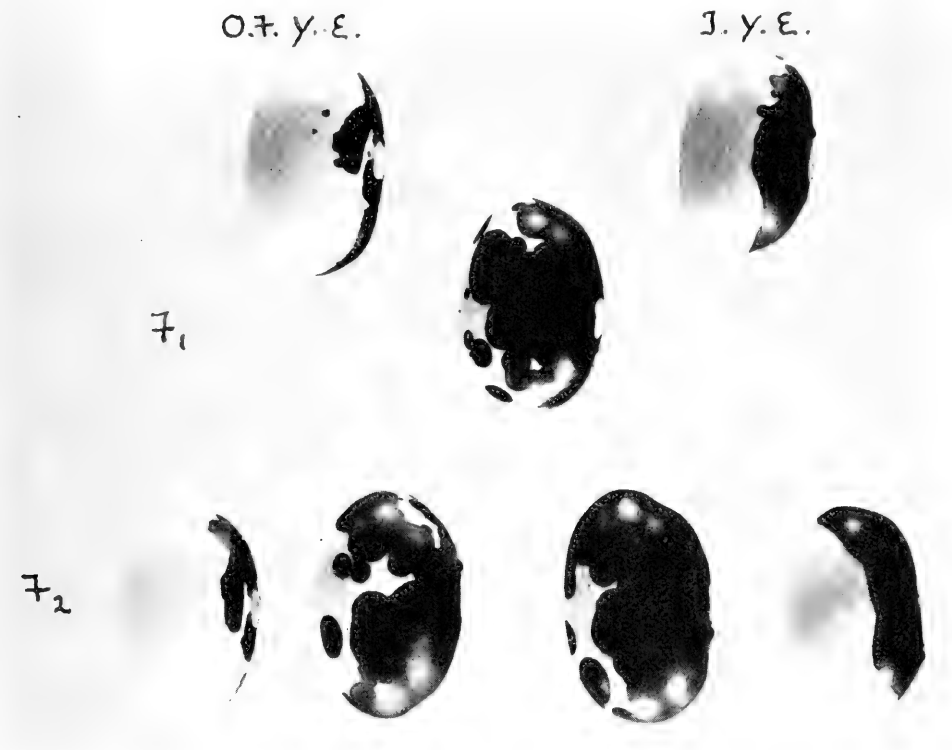
THE RESULT OF CROSSING EYED BEANS WITH WHITE

Figure 7. The first generation is dark mottled, and in the second are found mottled, solid colored, eyed, and white beans. The fact that crossing two light colored strains produces such dark beans is accounted for by assuming that the white parent carries an "Extension factor" that spreads the pigment, confined in the eyed parent to the region of the hilum, over the entire seed. Two or more extension factors may act with different colors of pigment, so that various patterns, with mottled or solid color backgrounds, occur. Photograph by C. H. White.

factors result in a character intermediate between the parents or resembling one parent or the other. In this cross of the eyed beans the factors in a heterozygous condition not only cause a great increase in area or amount of pigmentation but also cause an entirely new eye pattern.

Eyed and White Beans

Crosses of eyed beans with white beans have given various types of segregation in the second generation. In the cross *I. Y. E.* × White 1333, the first generation was dark mottled and the second generation gave a ratio of 27 mottled: 9 solid: 12 eyed: 16 white. When two extension factors are present one factor may extend one class of pigments while the other extends another pigment, so that we may get an eye pattern on a solid or mottled background. This type of pattern is shown in the last bean of the eyed series in Figure 7. Usually the eye is yellow or black while the



CROSSING EYED BEANS

FIGURE 8. The cross, Old-Fashioned Yellow Eye × Improved Yellow Eye, results in "piebald" beans in the first hybrid generation which have over twice as much pigmented area as either parent. The second generation ratio is 1 *O. F. Y. E.*: 2 piebald: 1 *I. Y. E.* The two alellomorphic factors for eye pattern when heterozygous cause a greatly increased extention of pigment, and an entirely new eye pattern. Photograph by C. H. White.

background is grey or light purple. The eye may be very definite in outline as in the *I. Y. E.*, or it may blend gradually into the white or pigmented background.

The great variability of the second generation segregates in crosses of eyed with white beans is shown in Figure 7. The color of pigment includes black, brown, yellow, purple, and red with a large series of intermediate shades. Numerous types of mottling are also found. The mottled pattern may consist of small irregular patches on a pigmented background or the background may be white. Often several mottling patterns are superimposed on one another. The patches of pigmented area may be of various shapes and sizes. In some cases the mottling pattern is associated with sunken areas of the seed coat. The uniformly pigmented beans also show great variability in color of pigment. In the second generation a large series of eye patterns are obtained ranging from individuals with more than ninety per cent of the seed coat pigmented to segregates which have only a small dot of pigment at one end of the hilum. In crosses of *I .Y. E.* × White involving several thousand second generation segregates the *I. Y. E.* parental type, in respect to size, pattern, and color, was rarely if ever recovered.

It is also found that factors for seed weight are associated with factors for

pigmentation, eye pattern, and extension factors. In all crosses of large eyed beans with small white beans the pigmented segregates in the second generation had a greater average seed weight than did the white segregates, It is estimated that about five or six size factors must be involved in most of the crosses studied. These size factors are independent in their effect and since they are often closely linked with factors for qualitative differences the effect of single factor differences for size can be studied.

TABLE 1. *Progeny of F_2 "Piebald" segregates*

Phenotype	*Observed No.*	*Observed Ratio*	*Theoretical Ratio*	*Probable Error*
Piebald	805	2.02	2	± 0.03
I. Y. E.	386	0.97	1	± 0.03
O. F. Y. E.	402	1.01	1	± 0.03
Totals	1593	4.00	4	

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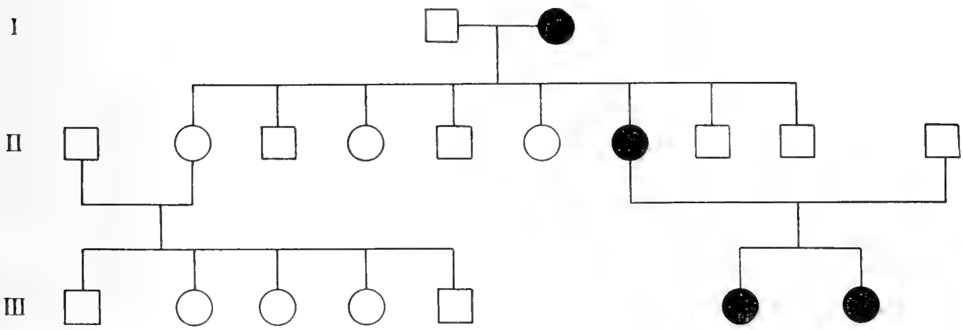
FURTHER DATA ON WEBBED TOES

W. E. Castle
Harvard University



WEBBED TOES IN FEMALE LINE ONLY

Figure 9. Considerable data have been presented previously in the Journal of Heredity on the inheritance of this character. In one case webbed toes appeared only in the male line, in all the rest of the families, both sexes were affected. In this family only the women have webbed toes, suggesting that the character is carried in the Y-chromosome.

The inheritance of webbed toes has been discussed in the Journal of Heredity by Hurlin,[1]* Schofield,[2] Schultz,[3] and Wright[4] and six different pedigrees bearing on the matter have been presented. A seventh pedigree has been sent in by a correspondent who points out that it does not accord with the interpretation of Y-chromosome inheritance suggested by Schofield's data.[5] In this, a Delaware family, the character has been observed in females only and is traced through three generations, involving four individuals (See Figure 9). It is noteworthy that there were three unaffected sisters as well as four unaffected brothers of the affected individual in generation II. The idea that the Y-chromosome may be the vehicle of transmission of the character suggested in connection with the Schofield pedigree is clearly not applicable to this family, but this case could be brought into harmony with that interpretation if we suppose that in man, as in certain fishes[6, 7, 8] either the X or the Y chromosome may be the vehicle of transmission, and genes may cross over from X to Y or *vice versa*. In this family obviously the X-chromosome would be a suitable vehicle, whereas in the Schofield family, the Y-chromosome alone would meet the requirements.

But if we extend the inquiry to other pedigrees reported by Hurlin, Schultz, and Wright, difficulties are encountered. Considering together all the seven pedigrees, sixty-five cases of transmission from parent to child are reported. The transmission is from father to son in forty-one cases, from father to daughter in seventeen cases, from mother to son in three cases, and from mother to daughter in four cases. Aside from the fact that the character is more often reported in males than in females, there is no reason to think that the character is either sex-linked or sex-limited. It is a simpler hypothesis to suppose that the character depends on the transmission of a dominant gene

*For Numbered References, see "Literature Cited" at end of article.

located in one of the ordinary chromosomes than to refer it to a gene located either in a Y or an X-chromosome. However, the Schofield genealogy, if correctly reported, suggests very strongly Y-chromosome transmission, since the character here passes from father to son, but not from father to daughter, nor through the daughter to the grandsons, as in X-chromosome transmission. If the Schofield genealogy has been correctly reported, I concur in the view expressed by Wright that the vehicle of transmission is not the same there as in the other families mentioned.

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[5] Castle, W. E. The Y-Chromosome Type of Sex Linked Inheritance in Man. *Science*, LV:703. 1922.
[6] Schmidt, J. *C. R. Trav. Laboratoire Carlsberg*, Vol. 14. 1920.
[7] Aida, T. *Genetics*, vi:554. 1921.
[8] Winge, O. *Jourl. Genetics*, xii:145. 1922

World's Dairy Congress To Meet

Great emphasis will be placed upon the possibility of improving dairy herds and increasing milk production by the careful selection of breeding stock and the gradual elimination of inefficient animals at the World's Dairy Congress. The sessions will be held at Washington, D. C., on October 2 and 3; at Philadelphia, Pa., on October 4, and at Syracuse, N. Y., from October 5 to 10.

The program is being designed broadly for four great groups and the topics of discussion have been arranged under the headings: I, Research and Education; II, Industry and Economics; III, Regulation and Control, and IV, National Health. The chairman of the Program Committee is Dr. L. A. Rogers, Director, Research Laboratories, Dairy Division, United States Department of Agriculture. Members of a Program Advisory Committee have been appointed by such national organizations as the breeders' associations, the Red Cross and the American Child Health Association.

About 200 papers have been prepared, about half by delegates from other countries. Most of these will be presented at Syracuse, where five sessions will be held simultaneously each morning. Two entire sessions will be devoted to breeding, heredity, efficiency and kindred topics. Among the papers will be: "The Wisconsin Experiment in Crossbreeding," by L. J. Cole; "The Inheritance of Milk Production and Butterfat Percentages," by J. W. Gowen; "The Development of the Dairy Shorthorn in England," by Major G. J. Buxton; "Measures Found Effective in Raising the Productivity of Danish Dairy Cows," by Lars Frederikson; "Relations Between Quantity and Availability of Calcium in the Ration and Yield of Milk Cows," by E. B. Meigs; "Some Aspects of the Physiology of Milk Glands," by Haakon Isaachsen, of Norway; "The Relation Between Nutrition and the Productive Function," by E. M. Evans. Among the speakers at these and other sessions will be: E. V. McCollum, of Johns Hopkins University; H. C. Sherman, of Columbia University; L. B. Mendel, of Yale University; Robert Burri, of Switzerland; R. H. Leitch, of Scotland; Willibald Winkler, of Austria; Osakar Laxa, of Bohemia; A. Miyawaki, of Japan, and Charles Porcher, of France.

THE HUMAN CONSTITUTION

A REVIEW

ANCIENT and medieval physicians were wont to classify mankind according to temperament—sanguine, melancholic, lymphatic, phlegmatic, bilious, and the like. With the progress of science, these more or less mystical categories were abandoned, and attention devoted to the detailed characteristics of the individual.

From this point of view it is evident that a man is merely the sum total of all his traits and characteristics. But as his characters are correlated with each other to some extent, it is not inconceivable that they might be so grouped as to justify the formation of classes of constitution, replacing the "temperaments" of older writers.

In the United States, little attention has been paid to the constitution, in this sense of the word, but during the last decade or two it has had a number of energetic students in Europe—Germany even has a *Zeitschrift fuer Konstitutions-Lehre* (Journal of the Constitution). Numerous books have been written on the subject, and one[1] of the latest of these, by Hans Gunther, furnishes a convenient opportunity to examine the ideas on which this study is based.

In the author's definition, the constitution is "the *organization* of the sum of the inner factors that make up a living organism" This, as the author admits, is abstract enough; it might lead to nothing more than a study of genetics, and the author, in fact, proceeds to discuss heredity and variation along conventional lines. He then describes the "norm," but as there are three different and equally valid norms (the mean, mode and median) it is practically impossible to establish any standard constitution for the human race, unless some arbitrary assumptions are made.

Here the author is obliged to admit that "We will never be able to grasp in its entirety the complicated structure of the constitution of an organism. Only individual characteristics, simple traits of character-complexes, are accessible." This might be thought to dispose of the need of any further study of the constitution as such. Instead, Dr. Gunther introduces a whole flock of "partial constitutions." In addition to the individual constitution there is the familial constitution, that of the local race, the race, and the species; on the other hand, there is the psychic constitution, the professional constitution, the clinical-sematic type, and so on. Again, the masculine constitution must be differentiated from the feminine; the latter, according to Aschner, is distinguished by the following characteristics:

"1. Less tension of the ligaments (hence enteroptosis is found as an anomoly in at least 30% of all women.

"2. Greater resemblance to the character of the child and greater tendency to infantilism.

"3. Greater irritability of the nervous system (tendency to hysteria and sensitivism, more intense and widespread erogenous zones).

"4. Quicker and richer production of blood and other fluids (tendency to congestion)."

Another classification, all too reminiscent of the "temperaments" of Hippocrates and Galen, is that of Sigaud and the French school, based on bodily form, which divides mankind into four

[1] *Die Grundlagen der Biologischen Konstitutionslehre*, by Dr. Hans Gunther, Privatdozent fur innere Medizin an der Universitat Leipzig. Pp. 136, 22 illustrations. Price, $0.65. Leipzig. Verlag von Georg Thieme, 1922.

types—the cerebral, respiratory, muscular and digestive. These are said to be hereditary, and so constant that they are distinguishable even among nurslings. Naturally, intermediate forms are also to be found; cerebro-muscular, and so on. It has been stated that the French military authorities make use of this classification for some purpose.

Numerous other classifications are proposed; the hypothenic (asthenic) contrasted with the hypersthenic, for example, and perhaps a dozen others of similar style and, it would seem, similar limitations.

Several chapters are devoted to diseases and abnormalities, and much information about human heredity is introduced; indeed, the somewhat bald outline of this review does not adequately suggest the large amount of information that Dr. Gunther has packed into his scheme. Several novelties are brought in; thus the author holds that when a recessive character (albinism, for instance) appears in a pedigree, the cases are not distributed haphazard but are governed by a rhythm which will result in, let us say, every third child being affected. This is inherently improbable, and would require more abundant proof than Dr. Gunther gives.

A bibliography of nearly a hundred titles shows that the study of the constitution does not lack exponents in modern Germany. Dr. Gunther's book, despite numerous points of excellence, does not seem to the reviewer to justify such a study. So far as theory is concerned, the attempt to embrace all human traits in a given constitution is likely to lead only to confusion and mysticism. And in practice the first thing that is done is to forget about the constitution and deal directly with the individual traits. To establish enough correlations among these traits to justify dealing with constitutions would require (assuming that it is possible at all) exhaustive statistical work, which has not yet been done. Much of the trustworthy research in this field has been unfavorable—the correlations expected on the basis of popular beliefs were found to be absent. To take a simple example, it has been shown that there is not a close relation between high intelligence and large skulls. At present the "Konstitutionslehre" appears, at the very best, to be well ahead of its time.

Paul Popenoe.

The Care of the Child

Heredity and Child Culture, by Henry Dwight Chapin, M. D., with a foreward by Professor Henry Fairfield Osborn. Pp. 219. Price $2.50. New York, E. P. Dutton & Co. 1922.

To trace, in a practical handbook for parents, the outlines of genetics and their relations to the training of the child, is a task well worth while. Dr. Chapin has undertaken it, but is not qualified to succeed in it because of lack of knowledge and lack of sympathy with eugenics. Having set out to deal with heredity, he naturally has to drag the subject in, and in a few early chapters gives an undigested mass of quotations, some facts, and some misstatements of fact; but by the time he reaches his last chapter, on the adoption of children, he has apparently forgotten all he ever knew about heredity. The bulk of the book is made up of the kind of material on the care of children, which appears in all other handbooks for parents.

P. P.

SELECTION IN BROOM CORN[1]

J. B. Park
Ohio State University, Columbus.

THE market value of broom corn is greatly influenced by the quality of the brush. Good heads should have long, slender, round fiber and be as free as possible from crooked, twisted, and kinky brush and from central stem. Brush having these undesirable characteristics is sorted out and sells at a very low price. Every crop contains a greater or less amount of this low grade product.

The opinion is common among growers that quality in broom corn is entirely controlled by seasonal conditions and that the kind of seed planted makes very little difference. Accordingly many growers use the most careless methods of securing seed, some even using seed from the broom corn thrasher where all kinds and qualities of brush are thrashed and the seed mixed.

The literature of broom corn improvement is meager indeed. Rothgeb[2] working in Oklahoma, found that varieties differ in productiveness, and that the differences are most pronounced in unfavorable seasons. He states that seed from commercial sources is likely to be of poor quality and he believes that strains which produce a more uniform quality of brush can be developed by selection of desirable seed heads. He states further that environing conditions influence the length and quality of the brush, thick stands tending to produce short brush and thin stands long coarse brush.

Central stem is illustrated in Figure 11. It is an extension of the rachis, varying greatly in length and thickness. Some stemmy heads are entirely worthless. From others the stem may be broken out by the broom-maker leaving the rest of the head of fairly good quality, but this involves labor and waste of material. If a strain could be produced which contained no central stem or a smaller proportion of it, the cash value of the crop would be greatly increased.

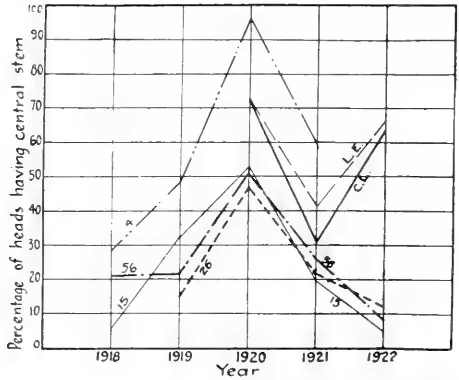
The experiment reported in the present paper was undertaken to show whether or not central stem is an inherited character and whether it can be reduced in amount or possibly eliminated by selection. Work was begun in 1917 by planting about one-tenth acre to the variety Longbush Evergreen from seed bought of an eastern seedsman. In the fall, 105 heads of good quality were selected from the crop and these were planted in the spring of 1918 in head-rows about thirty feet long. In the fall of 1918 a few of the best quality rows and some other typical ones were chosen, the brush was harvested and statistical measurements recorded for length of brush, degree of fineness, amount of kinky brush, and of central stem.

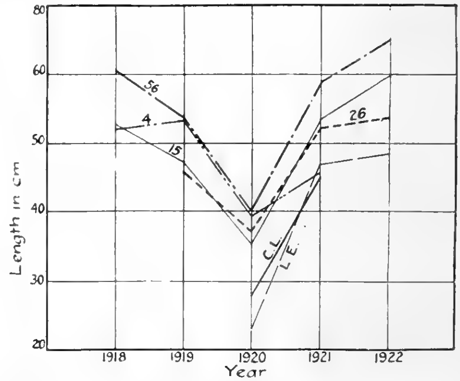
These first head-row populations, grown from open pollinated seed, showed in many cases a decided family resemblance within the head-row and conspicuous differences between rows. See Table 1.

For example, strain 56 is characterized by a moderately fine fiber. Strain 46 has short brush with a high percentage of the heads containing central stems.

[1] Contribution from the Department of Farm Crops, Ohio State University, Columbus, O. The author desires to acknowledge the assistance of Messrs. L. E. Thatcher, D. N. Lutz and H. L. Borst, who successively have been associated with him in this work.

[2] Rothgeb, B. E. Broom Corn Experiments at Woodward, Okla. *U. S. D. A. Bul.,* 836. 1920.





RESULTS OF FIVE YEARS OF SELECTION

FIGURE 10. On the left is shown the yearly variation in percentage of central stem in four selections of broom corn, compared for the last three years with two commercial varieties, Longbrush Evergreen (L. E.) and California Longbrush (C. L.) On the right is shown the variation in length of stem in the same varieties. Yearly variation in seasonal conditions generally affects all varieties similarly, but in 1922 the amount of central stem increased considerably in the commercial varieties, and decreased in the selections. The reasons for this are discussed on page 215.

The degree of uniformity within a head-row, on the whole was decidedly greater than usually occurs in ear-rows of maize, except after inbreeding, indicating that a considerable amount of self pollination occurs naturally in broom corn as no bagging of heads was done the first year. Beginning with 1919, some heads have been bagged each year and a full setting of seed has always resulted, showing the existence of complete self-fertility. In most cases selfed seed from bagged heads has been planted, but some open pollinated heads were used when a satisfactory number of good quality bagged heads were not available.

Since 1918 selection has been continued within a few of the better strains, first for freedom from central stem and after that for good length and fineness of fiber. In 1920, and each year since then, Longbush Evergreen and another variety, California Longbrush, both secured from a commercial seedsman, have been grown in comparison with the selections. The two varieties have been propagated by compositing seed from a random sample of the marketable brush, rejecting the badly twisted and worthless stemmy heads, but including the better grade of stemmy ones.

Of the original 105 heads planted in 1918 the number represented by progeny has rapidly decreased in successive years, due to the dropping out of inferior strains, until in 1921 only three remained of the good quality strains. The performance of four strains through five generations is shown graphically in Figure 10.

The values in the graphs are yearly averages of several head rows representing four of the original strains, each average involving from 100 to 1,000 plants.

Environmental Influence

That seasonal conditions have a pronounced effect on the amount of central stem and upon length of brush is evident from a study of the graphs. The values fluctuate widely from one year to another but the relative positions of the strains are fairly well maintained and all the strains and varieties show about the same kind and degree of response to seasonal influences.

The year 1920 was a very favorable crop season at Columbus, yields of small grains and of corn being high.

"CENTRAL STEM" IN BROOM CORN

FIGURE 11. On the left are shown three heads having the undesirable character, central stem. On the right are two stemless heads. Central stem greatly reduces the value of the crop because "Stemmy" heads are of small value in making brooms. The fact that seasonal conditions cause the amount of central stem to vary from year to year has led growers to believe that the kind of seed used made no difference. The present investigation shows that this is by no means true. It is quite possible to select strains that produce only a relatively small number of "stemmy" heads even in unfavorable years. As yet no strain has been isolated that is entirely free from this undesirable character.

The season of 1921 was a poor one for all grain crops, because of drought. The following year was slightly more favorable. Apparently conditions which favor long brush also produce a low percentage of stem and vice versa, though it is not easy to see just what elements in the environment produce the effect.

An exception to the uniformity of the seasonal rise and fall of the curves in Figure 10 occurs in 1922 when all the selections show a low per cent of stem, but the two commercial varieties show unusually high percentages. Also the correlation of low percentage of stem with long brush which prevails elsewhere is reversed in this case. This nonconformity of the 1922 crop is difficult to interpret. Does the small amount of stem indicate progress in the selection towards its elimination, uni-

formly effective in all three strains, or is the low stem content due to the season? Evidence that the summer of 1922 favored low stem content was obtained accidentally, and is presented herewith.

In 1922, because of severe damage to the selected seed-heads by birds and insects, it was deemed wise to plant some seed from the 1920 crop to insure continuation of the strains. This seed came from remnants saved from the previous year's planting and from some second-choice heads that had been saved over, all of which were free from central stem. The data secured from this planting show that the two-year-old seed of the three selected strains when planted in 1922 produced a crop containing 11.1 per cent of central stem, whereas essentially the same seed planted the previous year had produced 22.4 per cent of stem. This shows that the season of 1922 favored low stem content. On the other hand, the sharp rise of stem percentage in the two commercial varieties in 1922 indicates a "stemmy season." No attempt is made to reconcile the two sets of facts, unless the method of securing seed of the two commercial varieties for planting the 1922 crop was unwittingly a selection for stem.

At any rate there can be no doubt that the changed environment in different seasons has an important influence on both percentage of stem and length of brush, and it is not surprising that many growers should conclude that quality is entirely controlled by the season. Yet one only needs to study the graphs, or better still to see the quality of the crops produced year after year by some of the selections in comparison with the commercial varieties, to be convinced that heredity also is an important factor in determining the character of the crop (see Figure 12).

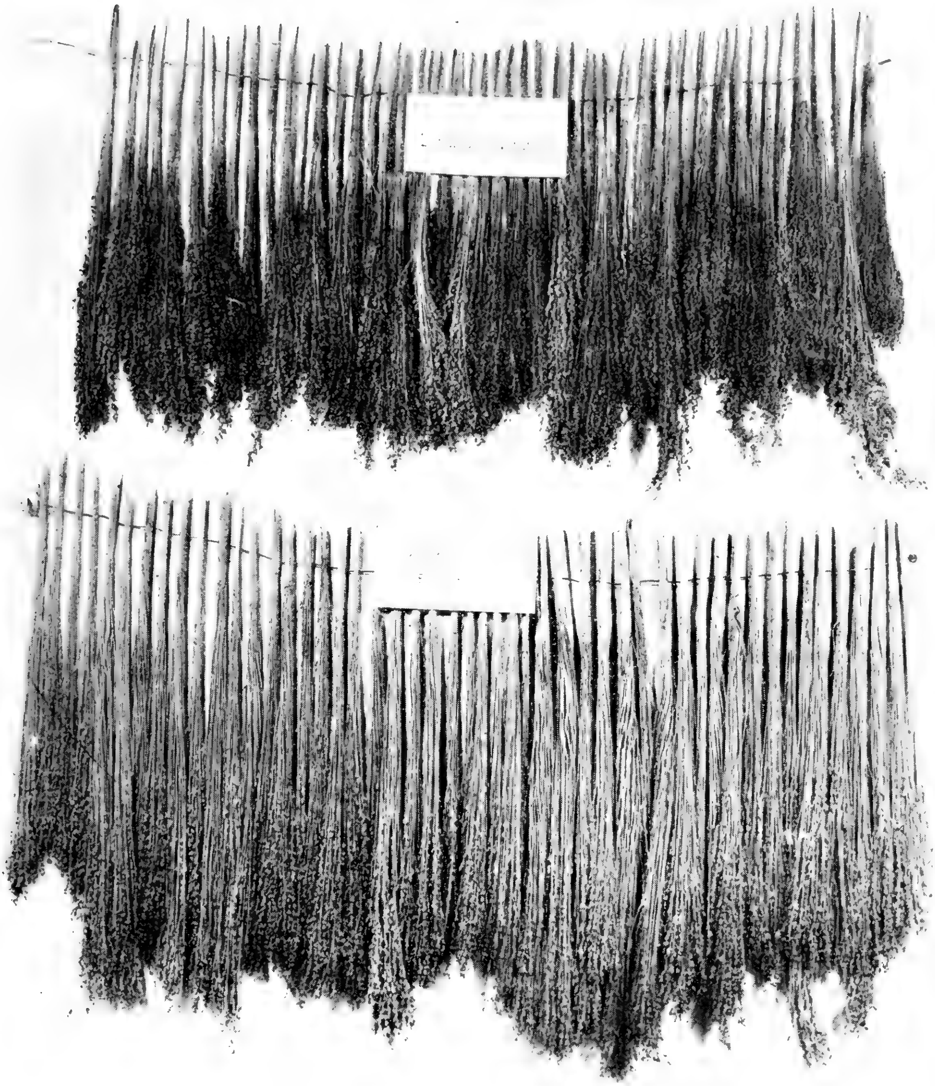
Genetic Factors

From the graphs it is evident that the three strains, 15, 26 and 56, isolated in 1917 and subjected to continuous selection for low percentage of stem, have maintained their individuality through five generations. No convincing evidence appears that these strains, after five years of intensive selection for low stem, have been changed genetically in any respect. During this time not a single head of these strains containing a central stem has been used for seed. And yet, so far as we can see through the fog of seasonal influence, they seem to have kept, practically unchanged, their original tendencies to produce similar relative amounts of central stem and lengths of fiber.

The only opportunity for making a direct comparison between two generations with environmental influence largely eliminated was the accidental one discussed above, when seed from the crop of 1920 was planted in 1922 to eke out the seed raised in 1921. The crop produced by seed of the older generation contained 11.1 per cent of stem and that of the younger contained 7.1 per cent. The significance of this difference is doubtful, although it may indicate some slight effect of selection.

The behavior of the strains as a whole strongly suggests that they are nearly pure lines. It is true there have been apparently good opportunities for selection to operate, as the different head-rows representing each strain have varied rather widely at times and only the strains which showed a low stem content were continued. Would these strains have remained at a relatively low level of stem production if continued selection had not been practiced? Our most direct answer comes from the behavior of the two commercial varieties which represent conditions of nonselection. They apparently have remained fairly constant genetically, although they are evidently made up of an admixture of strains.

In 1918 strain 4 had a relatively high stem content, but as it was desirable in other respects, stemless heads were selected for planting. In 1919 two head-rows produced respectively forty-



PROGRESS IN THE IMPROVEMENT OF BROOM CORN

FIGURE 12. This shows what has been accomplished in five years of selection. Characteristic heads of the parent strain, and of strain 56, selected from it, are shown. In 1922 the former had over six times as many heads containing central stem as the latter. The fibre of the selection is also finer, more uniform, and longer than that of Longbrush Evergreen grown under similar conditions.

nine and fifty-one per cent of central stem, which was taken to be sufficient evidence that this was a high percentage stem producer. It was then decided to try selection in the opposite direction by choosing seed heads which contained large central stems. The season of 1920 was a "stemmy season," as observed above, and these stemmy heads produced a crop that had ninety-six per cent of stem. The next year's crop contained fifty-nine per cent. A similar selection for stem had been started a year earlier in strain 45 and it produced fifty-seven and eighty-three per cent of stem in the years 1919 and 1920 respectively. All progeny of original plant No. 4 have shown a tendency toward high per cent of stem. Strain 45, however, produced some substrains that were fairly low in stem and others that were high, indicating that it was heterozygous for stem content, while strain 4 seemed to be relatively homozygous.

It seems, therefore, that the open pollinated heads selected in 1917 were largely homozygous. Subsequent head-row cultures made possible the sorting out of those which were most nearly homozygous for low stem content, and at the same time of desirable quality in other respects.

The conception of the broom corn crop gained from this experiment is that for breeding purposes it should be classed between the self-fertilized crops and the open-pollinated ones. Practical breeding, then, would begin as usual with a study of available types and varieties. From the best varieties a considerable number of desirable heads would be selected and given a progeny test in head-rows. After one or two years in head-row tests the better strains could be composited and increased; or a single strain might be increased for commercial planting. Bagging of heads is easily done and is probably worth while to insure self-pollination. There is no apparent reduction in vigor due to selfing, which is to be expected since it is shown that a large amount of natural selfing occurs. Mass selection without a progeny test in head-rows would accomplish little, or at best would make but slow progress in broom corn, for it has been shown that many good quality heads produce a mediocre or low-grade progeny. The head-row test detects these and makes it possible to distinguish between strains whose parents looked alike but were genetically different, as proved by their offspring.

It seems to be clear that central stem in broom corn is an inherited character, for different strains produce it in differing amounts; yet none has been found that produces a progeny free from this undesirable feature. Possibly multiple factors are concerned; in which case crossing of strains with low percentage of stems, followed by observation of numerous head-rows, should discover the desired stemless individuals.

That production of central stem is closely tied up with the physiological condition of the plant is indicated by our observations. When for any reason the head fails to emerge from the leaf sheath, or is retarded in its development by accident, a branch usually starts from one or more nodes of the stalk. These branches usually attain a length of several feet and produce a small, worthless brush that invariably has a central stem. Stem is always present in these branch heads, even on plants of which the partially developed main head was free from central stem. It may be that the forces which cause or allow stem to be produced in the heads of these branches are the same as those involved in the seasonal effects noted above. But further experiment would be required to make this point clear.

The method mentioned above of eliminating seasonal influence by growing two or more generations in the same season appeals to the writer as

being an important aid in many plant breeding experiments where seasonal influences obscure the effect of genetic factors. Of course, the idea is old, and has been used many times, but the method deserves wider recognition and more general use. It is best adapted to experiments with those plants that produce an abundance of seed which is viable over a period of years. With several generations of a selection experiment all growing side by side, progress could be measured with much greater accuracy than by comparing generations of plants which were grown in different seasons.

TABLE I. *The average values for certain characters in typical head-row populations of broom corn,* 1918.

Strain	Average length. Cm.	Percentage of central stem	No. of plants
30	48.7	13.0	69
50	53.6	22.7	101
15	52.9	5.9	84
102	49.8	16.0	74
56	60.4	20.2	89
2	52.0	17.3	69
4	52.6	29.4	73
45	46.3	15.7	70
84	53.1	20.9	62
16	56.2	21.3	75
46	42.8	36.6	60
7	50.9	18.8	69
3	49.3	25.2	91
103	49.5	17.7	62
86	49.5	39.7	83

The Protection of the Germ Plasm

KEIMESFUERSORGE: Entstehung und Verhuetung der Schwangerschaftsstoerungen, by DR. ALFRED GREIL, Insbruck. Pp. 27. Price, 16 cents. Leipsig, Verlag von Curt Kabitzsch, **1923.**

That the child's future is largely influenced by the conditions surrounding the embyro, and particularly by the presence of various bodily poisons in the mother's blood, is Dr. Greil's thesis. This proposition is expounded in a detailed and sometimes startling way; but the treatment is dogmatic (perhaps necessarily so because of the brevity of the paper), and the reader is given no idea of the evidence behind many interesting statements. Dr. Greil holds that the gametes deteriorate rapidly after separation from their place of origin, hence the importance that zygosis should occur promptly. Thereafter, the most important feature of his program seems to be a not too nitrogenous diet for the mother. A statement of the necessary conditions for the maintenance of health in the germ-plasm is given. It is announced that an English edition of this pamphlet is in preparation; it is much to be desired that the author present some of the evidence underlying his views, since it is not generally familiar to geneticists, who will have to be shown the facts before admitting that the author's ideas are anything more than "important if true."—P.P.

A WHITE-HAIRED, BLACK-EYED MUTANT OF THE OLD ENGLISH RAT

FIGURE 13. Wild white rats were discovered at Bristol, England, in 1920. They proved not to be escaped fancy rats (*Mus norvegicus*), but were evidently a mutation of the English Black Rat (*M. rattus rattus*). Attempted crosses with *norvegicus* have not succeeded, but these white rats cross readily with the black. Interbreeding the white individuals has produced only white rats, and crosses with black rats indicate that the character is recessive to normal coat color. Females are relatively rare in this strain. The numbers available are small, but they indicate quite a wide deviation from the normal sex-ratio.

A MUTANT OF THE OLD ENGLISH RAT

F. A. E. CREW

Animal Breeding Research Department, University of Edinburgh, Scotland

WILD white rats were reported in certain warehouses in Bristol in 1920, and a well-known fancier, Mr. H. C. Brooke, of Taunton, took steps to secure live specimens. He expected to obtain feral fancy fats (*Mus norvegicus*), but to his great astonishment the rats he received were all black-eyed, creamy-white specimens of *Mus rattus rattus*, the Old English Black Rat. He ultimately obtained two Black-eyed Whites, and two Black-eyed Fawns, one of the latter being sexually immature: all four were males. A pregnant black-eyed pale-fawn female was caught, and still another black-eyed white was reported to be in the hands of a fancier of Bristol. Accurate information as to the number of the rats seen before Mr. Brooke heard of them is not available, and it is not known whether such rats are still to be found in the locality.

Below are given the results of the breeding work carried out by Mr. Brooke. Since the discovery and first description of this new variety of *Mus rattus rattus* were made by him, I propose to give the name *Mus rattus rattus* var. *brookei* to it.

TABLE I—*Crosses of the White Mutant Rats Made by Mr. Brooke.*

Parents		Offspring					
		Black		*brookei*		agouti	
♂	♀	♂	♀	♂	♀	♂	♀
1. *brookei* (w)	× wild black	4	3	—	—	—	—
2. *brookei* (w)	× wild white-bellied agouti	—	—	—	—	5	4*
3-6. *brookei* (w)	× F_1 from (2)	1	—	7 (w)	3 (w)	6	4
7. *brookei* (f)	× wild yellow-bellied agouti	—	—	—	—	3	2+
8. *brookei* (f)	× F_1 from (7)	—	1	2 (f)	3 (f)	1	—
9. *brookei* (w)	× wild black (extracted)	—	1	—	—	3	1
10. *brookei* (w)	× heterozygous black	3	3	6 (w)	2 (w)	—	—

w, white; f, fawn. *Mr. Brooke reported that some of these were white- and others grey-bellied; + that some were grey- and others yellow-bellied.

TABLE II—*Results of Breeding Work With White Mutant Rats in the Animal Breeding Research Department*

Parents		Offspring			
		Black		*brookei* (white)	
♂	♀	♂	♀	♂	♀
1- 4. *brookei* (w)	× wild black	13	18	—	—
5- 6. F_1 from (1-4)	× F_1	4	6	2	—
7-12. *brookei* (w)	× F_1 from (1-4)	10	8	12	3

Many *brookei* × *brookei* matings were made and invariably yielded nothing but creamy-white black-eyed individuals, but it was remarkable that females were relatively rare.

Mr. Brooke sent some of the males to me and the results of the breeding work carried out in this Department are given below.

The rarity of the *brookei* female is again noteworthy.

Several matings of *brookei* × *brookei* have been made and the progeny are invariably black-eyed creamy-whites, no matter how the parents were obtained.

The outstanding characteristics of this new variety of *Mus rattus* are the bulging jet-black eye, the creamy-white body color, and the slaty color of the skin of the ears and tail. Every opportunity has been offered both by Mr. Brooke and by myself for the mating of these rats with the fancy rat (*norvegicus*), but no such mating has occurred. The two species live together harmoniously and will foster each other's young. Individuals fostered by tame *norvegicus* does and handled frequently from their earliest days become just as tame as their foster parents and give up their nocturnal habits.

The breeding results suggest that the mutant variety of the Old English Black Rat has a coat color which behaves as a recessive character when tested against the black coat color of the parent stock.

The specimens referred to as fawns were not quite similar in color to fawn "fancy" rats or mice, being more biscuit-colored. They were also rather paler than the Fawn *Rattus rattus* produced by Hagedoorn and Bonhote, differing from the latter also in that their eyes were always black, whereas Bonhote records of his Fawns that their eyes were dark ruby when young, darkening with age as in the Cinnamon Canary.

A British Journal of Experimental Biology

HITHERTO there has existed in Great Britain no journal which served specifically for the publication of researches in experimental biology lying outside the confines of genetics on the one hand, and traditional human physiology on the other. American workers who have created a powerful impetus towards experimental inquiry in biological science will, it is hoped, welcome the announcement that a British Journal of Experimental Biology will appear in September, 1923, issued by Messrs. Oliver & Boyd, from the Animal Breeding Research Department at Edinburgh. While a primary object of the Journal will be to promote in Great Britain the extension of inquiry along experimental lines, it is the earnest hope of the Editorial Board that American and continental scientists will give their support not only by subscribing but also by offering contributions for publication.

All communications should be addressed to the Managing Editor, the Animal Breeding Research Department, the University, Edinburgh, Scotland.

F. A. E. Crew,
W. J. Dakin,
J. Heslop Harrison,
Lancelot T. Hogben,
Julian S. Huxley,
J. Johnston,
F. H. A. Marshall,
Guy C. Robson,
A. M. Carr Saunders,
J. MacLean Thompson.

IN THE MELTING POT

IT HAS long been charged and to a large extent proved that the immigration of recent decades into the United States, coming of late years largely from the Mediterranean region and the Near East, is eugenically below the average of the older immigration, and of the American stock of native parentage, both of them largely Nordic in composition. Army mental tests proved this clearly as to general intelligence,[1] but the fact can be tested in many other ways.

The House of Representatives Committee on Immigration and Naturalization has been holding hearings during the past winter, and called on Harry H. Laughlin, superintendent of the Eugenics Record Office, for information as to the foreign-born in institutions for the defective and delinquent in the United States. His testimony has been issued by this committee, and forms a pamphlet[2] of 106 pages packed full of interesting information.

Dr. Laughlin's method of attack was to calculate a normal quota for each group of foreign-born in the United States, in a classification which embraced all the principal countries of the world and ran up as high as No. 67, "born at sea."

Taking a given institution population,—say the feebleminded,—the percentage of this population to the total population of the United States was taken as 100. Then if the Italians, for instance, represented (as measured by the 1910 census) 1.46 per cent of the total population of the United States, it was calculated that they ought to represent 1.46 per cent of the total population of the feebleminded institutions in the country, if their showing in this respect were "normal." The extent to which any group exceeded or fell short of its quota, calculated in this way, was taken as indicating its standing in comparison with the United States population as a whole, and with other groups figured in the same manner.

The statistical difficulties of interpretation of such figures are quite obvious, and doubtless no final validity would be claimed for any of them. To follow up the illustration already adopted, it is clear that the extent to which the Italians fell short of or surpassed their quota would be influenced by such important factors as the age and sex of immigrants, the regions in which they settled in the United States, the tendency of race or religion to take care of its own dependents, and the like. While such questions make all comparison provisional, Dr. Laughlin is undoubtedly justified in claiming that where a group's "quota fulfilment" exceeds 200 per cent, in connection with a small probable error (which he calculated in all cases), that group deserves further examination from the point of view indicated.

The Italians—to conclude with the illustration chosen, were entitled to 247 inmates of feebleminded institutions, but only 64 were found. In this respect, then, they fulfilled their quota to the extent of only 25.4 per cent. As compared with the population at large, it appears that the Italian immigrants either have a small per cent of feebleminded, or else their feebleminded for some reason do not get into America's public custodial institu-

[1] See Popenoe, Paul. Intelligence and Race: A review of some of the results of the army intelligence tests. I, the foreign born. *Journal of Heredity*, Vol. XIII, No. 6, pp. 265-9, Washington, D. C., June, 1922.

[2] "Analysis of America's Modern Melting Pot." Hearings before the committee on immigration and naturalization. House of Representatives, 67th Congerss, 3rd session, November 21, 1922, Serial 7-C. Statement of Harry H. Laughlin, Washington, Government Printing Office, 1923.

tions; or both explanations may conceivably apply.

The fact is that nearly all of the foreign-born groups fell short of their quota for feeblemindedness—a fact without much significance when it is remembered that only a fraction of one per cent of the estimated number of feebleminded in America is to be found in custodial institutions. The Serbians make the worst showing, with a quota fulfillment of 220.62 per cent.

Segregation of the insane is fairly complete, hence the data under this head should be more significant. All foreign groups except Japan, China, and Switzerland exceed their quotas, running up to such high percentages as

Turkey	200.12
Russia, Finland and Poland	265.1
Bulgaria	300.19
Ireland	305.2
Serbia	400.34

The reasons for the excessive prevalence of foreign-born in American hospitals for the insane have been abundantly discussed, and it is not necessary to enter into them here. Unquestionably part of the explanation is that peasants from a simple environment find the stress of American life, especially in the cities, too much for them.

The statistics of crime are even more instructive. All the Nordic countries stand well, falling notably short of their quotas; and the foreign-born as a whole do not quite reach their quota (98 per cent fulfillment). The bad showing of certain countries is therefore all the more conspicuous. In addition to the American negro (207 per cent), the groups which more than double their quotas are:

Italy	218.2
Turkey	240.17
All Asia	251.7
All Balkans	275.6
Greece	293.9
West Indies	318.14
China	337.12
Bulgaria	366.26
Mexico	549.6
Spain	660.21
Serbia	1400.2

This showing is based on records of the inmates in 155 state and federal institutions. In some cases it may be that a given race is discriminated against in law enforcement in some parts of the country, but this can not explain away all of the cases. On the whole, it can hardly be doubted that certain of the countries from which the United States has drawn a large immigration during the last quarter century have been sending their dregs.

The small figures published for epilepsy indicate that the bulk of the institutional inmates are native born. As to tuberculosis, the Balkan states (379 per cent) and Greece (436 per cent) are naturally topped by the American Indians (573 per cent). In blindness, deafness, and deformity the foreign-born are less represented than the native-born. As a rule, persons with such deformities would not come as immigrants, and would not be admitted if they came.

For self-preservation, it would seem that the United States has the right, and the duty, to require that immigrants shall be superior to the average, rather than inferior. Evidence from many different sides indicates that during the decade or two prior to the recent restriction laws, the immigration tended to be more inferior. The present restrictive (three per cent) law tends more or less indirectly to bring in a better quality of immigrants, but it is generally admitted that other measures of selection as well as restriction are desirable. The ideas of one student of this question are given in the testimony of Dr. Laughlin on this point:

> In addition to the medical requirements now listed, there should be added an examination into the potential parenthood of the immigrant for the purpose of determining whether, in the normal course of future years, in the United States, the immigrant is physically capable of becoming a parent.

2. The standards of mental ability and personality should be measured by a series of modern psychological tests.

3. The reputation of the immigrant in relation to his home community should be considered.

4. The family history of the immigrant should be made an important factor in judging of his future personal worth, and of the hereditary qualities which he would probably pass on to his children.

5. The American people should establish a system of "immigration attaches" and "immigration passports" in our consular service. Data on personal and family history and on reputation should be required by and should be furnished to the "immigration attache" who would vise the "immigration passport." only in case the immigration standards of the American nation were met in every way. The additional requirements which I have just listed would go a long way toward establishing the standards which the American people desired to see adhered to.

6. The immigrant should be registered, and a registry should be maintained of all foreign-born in the United States. The immigration admission paper should be the first registration card, which should be retained by the alien, and annually examined by the United States, until the immigrant becomes a citizen of the United States, or until he dies or is deported.

7. The deportation system, which is the object of a survey now being completed, is the last line of defense in our national battle against undesirable alien qualities. If an alien remains, legally or illegally, in the United States for five years or longer, we can not deport him; but we must keep him and his progeny indefinitely for better or worse. We should admit and welcome superior qualities of body and mind in aliens, but, at the same time, we should exclude the undesirables, and if by chance some undesirables get in, despite our efforts at exclusion, we must deport them.

It should be possible to control immigration in such a manner that every immigrant would constitute a natural asset: first, a present economic asset; second, a future social asset; third, an asset to the natural hereditary qualities of the race in case the immigrant becomes the parent of sound and intelligent offspring.

PAUL POPENOE.

Books Received

Proceedings of the Second International Congress of Eugenics, Volume 1, *Eugenics, Genetics and the Family;* Volume 2, *Eugenics in Race and State.* Williams and Wilkins, Baltimore, 1923.

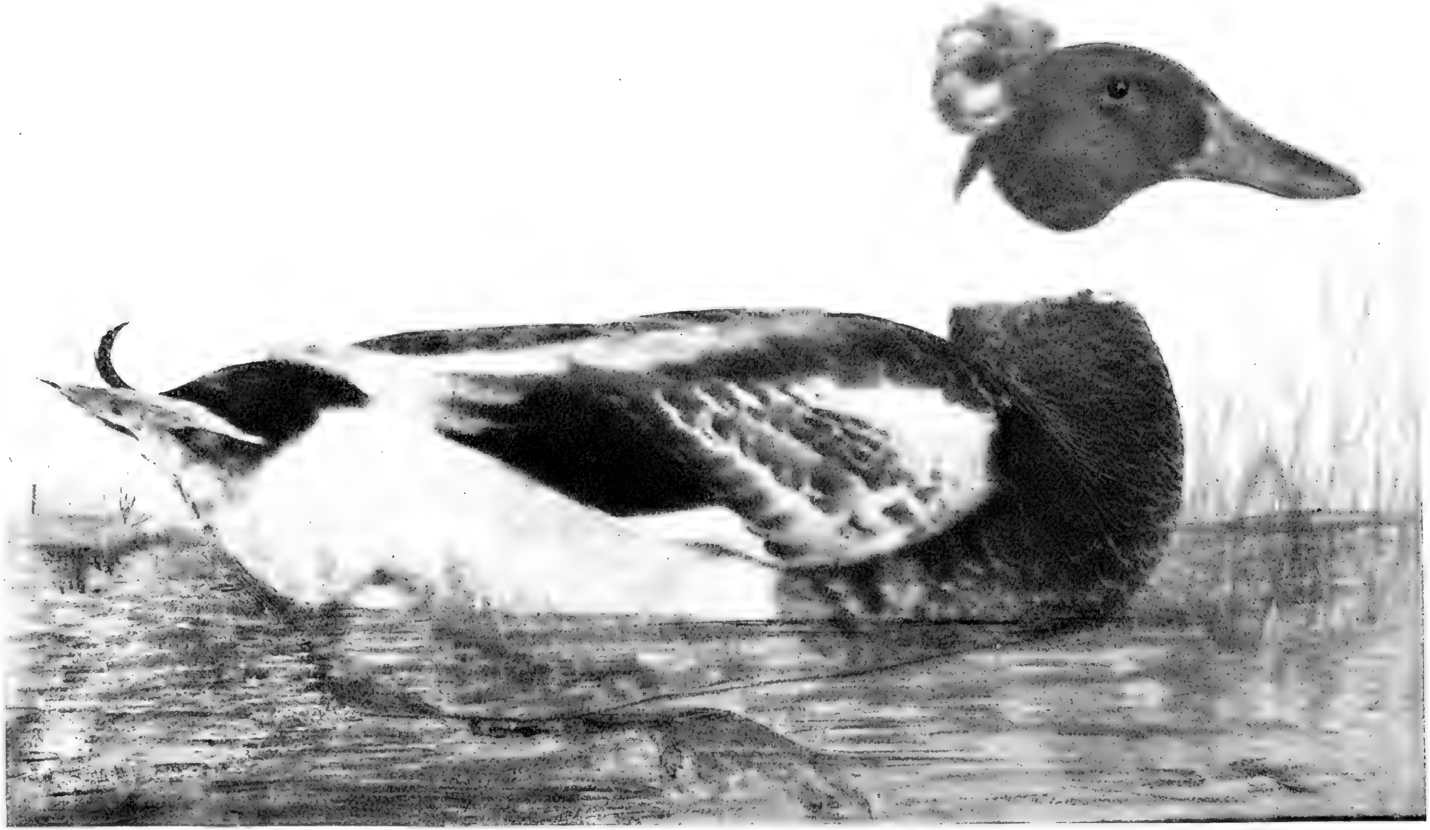
Studies in Mental Deviations, by S. D. PORTEUS. Publication Number 24 of the Training School, Vineland, N. J.

Heredity in Poultry, by REGINALD CRUNDALL PUNNETT. The Macmillan Company, New York and London. 1923.

Of What Use Are Common People?, by HEINRICH BUCHHOLZ. Warwick and York, Baltimore. 1923.

The Index to Volume XIII

The index to Volume XIII is not yet ready, but is now in preparation and will be mailed to members shortly. The regrettable delay in its publication has been occasioned by the unexpected closing of the last volume, a greatly increased amount of work having been entailed by the changes made at that time.



A CRESTED MALLARD DRAKE

FIGURE 14. On the head of this drake is a soft topknot of feathers, quite unlike the crests found in certain wild species of ducks. Darwin noted the existence of such tufts, and stated that the skulls of the tufted individuals were rounder than usual, and that they were perforated with numerous small holes. No data are available as to how this character originated, or is inherited, and any information on these points would be appreciated by the author.

CRESTED DOMESTIC DUCKS

R. W. Shufeldt
Washington, D. C.

VARIOUS species of ducks in nature are crested, their crests being, as a rule, composed of elongate, soft, feathers, directed backwards, and only partially raised during certain moods of the bird. Mandarin ducks of the Orient possess such a crest, as does, to some extent, our own wood duck. However, no wild duck known to me has such a crest as the one shown in the illustration. I brought this bird home alive from Center Market, Washington, D. C., early in November, 1922, it being a drake mallard of great size, doubtless due to the fact that it came from a stock into which had been bred other species noted for that character.

At the middle point at the back of the head of this mallard was a soft, roundish ball of feathers, which has generally been referred to as a "crest;" though, as a matter of fact, it is no such crest as we meet with among wild ducks or their near allies, such as the hooded merganser and those anserine species that possess soft and drooping crests. Many ducks are exposed for sale in the Center Market at all times of the year, and I pass, almost daily, the place where a great many of them may be seen in crates; but I may say that in the course of a year or so I have not observed more than three or four having such a crest as is here shown in the figure. I borrowed the bird from the dealer, made the photograph of which the accompanying figure is a reproduction, and returned the loan.

Now comes the question as to how such a crest could have originated in a line of ducks, either ferine or domesticated, when they are noted for being especially devoid of such a feature. No mallard in nature ever exhibited such a crest—nor does any other species, in so far as I am aware. Breeders of domestic ducks appear to be entirely ignorant of its origin; they say it is a "freak," which means nothing. The statement fails to explain anything; and, freak or no freak, it must have arisen somehow.

In referring to this particular character, Darwin made the statement that in some ducks "a tuft of feathers on the head is by no means a rare occurrence; namely, in the true tufted breed, the hook-billed, the common farmyard duck, and in a duck having no other peculiarity which was sent to me from the Malayan Archipelago. The tuft is only so far interesting as it affects the skull, which is thus rendered slightly more globular, and is perforated by numerous apertures."* This statement in no way *explains* the origin, or probable origin, of such a crest; and it further complicates the question through announcing what is to be found in the skull of ducks possessing such a crest.

Up to the present time I have not examined the skull of a duck having one of these feathery topknots—in any event it is quite secondary to the matter of the presence of the crest and the manner of its origin. I note that Darwin did not take up that matter; and so far as I know, he left no explanation as to how such a crest came about.

Should any reader of THE JOURNAL of HEREDITY possesses information on this point, I would be very glad to know about it.

* Animals and Plants Under Domestication, Vol. I, p. 339.

THE GENETICS OF JACOB

R. E. Stone
Department of Botany, Ontario Agricultural College.

THE science of genetics is twenty-one years old, but the foundations upon which genetics rests are very old indeed. The very beginnings are prehistorical, and enough information on heredity was early acquired to give rise to certain systems of selection in animal breeding.

Jacob, for example, was able to mulct his father-in-law through a definite system of selection and mating. That Jacob was in advance of many in his time there is little doubt, and also there is little doubt that he did not care to have his associates learn the secret of his success. He was, throughout his whole life, mainly concerned with the advancement of Jacob and Jacob only. Although we may agree that this son of the chosen people was a consummate rogue, we often do him injustice on the score of knowledge.

In the book of Genesis 30:27-42 there is set forth in detail a system which Jacob is supposed to have used in order to influence the color of his flock. This passage is often cited to show that Jacob believed in the efficacy of maternal impressions. A careful reading of the chapter shows that he realized the importance of segregation, as he put three days journey between his spotted herd and the flocks of Laban. Furthermore, this account has been written by an observer not concerned in the material aspect. We get a clearer understanding of Jacob's notions concerning breeding if we read Genesis 31:8-14, which purports to be Jacob's own account of his procedure:

> "If he (Laban) said thus. The speckled shall be thy wages; then all the cattle bare speckled; and if he said thus. The ring-straked shall be thy hire; then bare all the cattle ring-straked. Thus God hath taken away the cattle of your father and given them to me, and it came to pass at the time that the cattle conceived, that I lifted up mine eyes, and saw in a dream, and *behold* the *rams which leaped upon* the *cattle were ring-straked,* and *speckled* and *grizzled.* And the angel of God spoke to me in a dream saying, Jacob, and I answered, Here am I. And he said, lift up now thine eyes and see, all the *rams* which *leap* upon the *cattle* are *ring-straked, speckled* and *grizzled,* for I have seen all that Laban doeth unto thee."

Jacob had been "stung" in his first contract with Laban. He had labored fourteen years to make good his slip and all this time had been trying to devise a means whereby to provide for his family. As a result of long brooding while tending his herds his "inspiration" came in a dream: Mixed breeding and isolation. To how many scientific men has the solution of a difficult problem come in the same way?

Taking the two chapters together it would seem that Jacob had observed the results of cross breeding, and probably also observed what took place when both parents were of the same type. Of course, we cannot now make a genetic analysis of Laban's cattle, but if "ring-straked, speckled and grizzled" are assumed to be dominant characters, we must recognize that Jacob's breeding methods were not based altogether on superstition. He realized the value of isolation and had some knowledge of the importance of giving the get an opportunity to develop under the most favorable conditions. Since the modern breeder makes use of the same principles it indicates that the art of breeding was fairly well advanced at that early period.—1746 (?) B. C.

THE INHERITANCE OF DEGREES OF SPOTTING IN HOLSTEIN CATTLE

L. C. Dunn, H. F. Webb and M. Schneider
Storrs Agricultural Experiment Station[1]

HOLSTEIN cattle, with their striking black and white coloration, are familiar features of almost every country landscape. Purebred Holsteins in the United States outnumber all other kinds of purebred dairy cattle combined and supply the greater portion of the milk and dairy products consumed in this country. In addition to mere numbers, they are interesting to the student of natural history because of the great variety of coat patterns in existence. Unlike other breeds, they have never been made to conform to a rigid standard of pattern. In fact, Holstein breeders have rather prided themselves on the absence of requirements in regard to coat pattern and have preferred to direct their breeding operations toward the perfection of a valuable milk producing type, uninfluenced by minor considerations of pigmentation. The only registry requirements relating to spotting are that the animal to be registered must be black and white; and that the following extremes of spotting are barred from registration: (1) solid black, (2) solid white, (3) black switch, (4) solid black with white only under belly, (6) black on legs beginning at feet and extending to kness and hocks or black with white interspersed in these parts. The relative amounts of black and white may and do vary within wide limits from nearly all white with black eyes, to almost solid black with traces of white on the extremities or belly. There has been of late years a tendency for some Holstein breeders to prefer the lighter types, while a few have favored the very dark types. These preferences have not been general and they have not influenced the breeding operations nor changed the general character of the breed to any marked degree.

The occurrence of nearly all degrees of black and white spotting provides additional marks of identification of the individual animals. Breeders have taken advantage of this fact and have kept sketch records of the spotting of each animal, and have made wide use of photographic methods for recording the type and coloration of their cattle. The Holstein-Friesian Association, which is the official registry office for this breed, now requires a standardized sketch of each animal submitted for registry and when one considers that over one million purebred animals have been registered, each entry accompanied by a descriptive sketch and a statement identifying both parents of the animal, the bulk and value of these records may be readily recognized.

In view of this wealth of interesting material, we were somewhat surprised to find, about a year ago, that the inheritance of the variations in the coat pattern of this breed had never been investigated. We decided to attempt such an investigation and Mr. Webb, then a student in the Connecticut Agricultural College, undertook to gather the necessary data as thesis material for an advanced course in genetics. He met with prompt and courteous cooperation from the officers of the Holstein-Friesian Association who placed the material in their registry office at Brattleboro, Vermont, at his disposal. It is also a pleasure to acknowledge here the help and suggestions of Professor G. C. White and Mr. L. M. Chapman of the Dairy Department of

[1]Contributions in Genetics No. 16.

THE LIGHT SIRE

FIGURE 15. King Model 18717 is a noted producer of superior offspring. He has about fifty units of black (roughly about five per cent) on each side of the body. By cows like himself he produced only light calves. By dark cows he produced medium and dark offspring. This is evidently the recessive color pattern in Holstein cattle. The few light calves produced in crosses with dark cows were doubtless due to the heterozygous condition of the dark parent. Photograph by courtesy of the Bloomingdale Farms, Somerville, N. J.

the Connecticut Agricultural College. Several leading breeders of Holstein cattle and the editor of the Holstein-Friesian World have very kindly supplied information and photographs. Their courtesy is acknowledged in the legends to the illustrations.

The Problem

The problems which we set out to study were:

(1) To define and describe the variations in the gross amounts of white spotting in Holstein cattle. The best preliminary information could be obtained, we found, from a study merely of the relative areas of black and white spaces in the coat, disregarding for the time, the variations in the character or arrangement of the spots.

(2) To find out whether variations in the amount of spotting were inherited.

(3) If inherited, in what manner.

Our plans for attacking this problem were more or less conditioned by the form in which the data were available. We decided that the most feasible plan was to choose individual males showing great differences in the amount of spotting, and to obtain for each male (1) his spotting description, (2) the description of a random sample of cows of all degrees of spotting with which he had been mated, and (3) the description of one or more offspring from each of these matings. This should provide a number of sire-dam-offspring trios, and should afford a test of the genotypes of the males, at

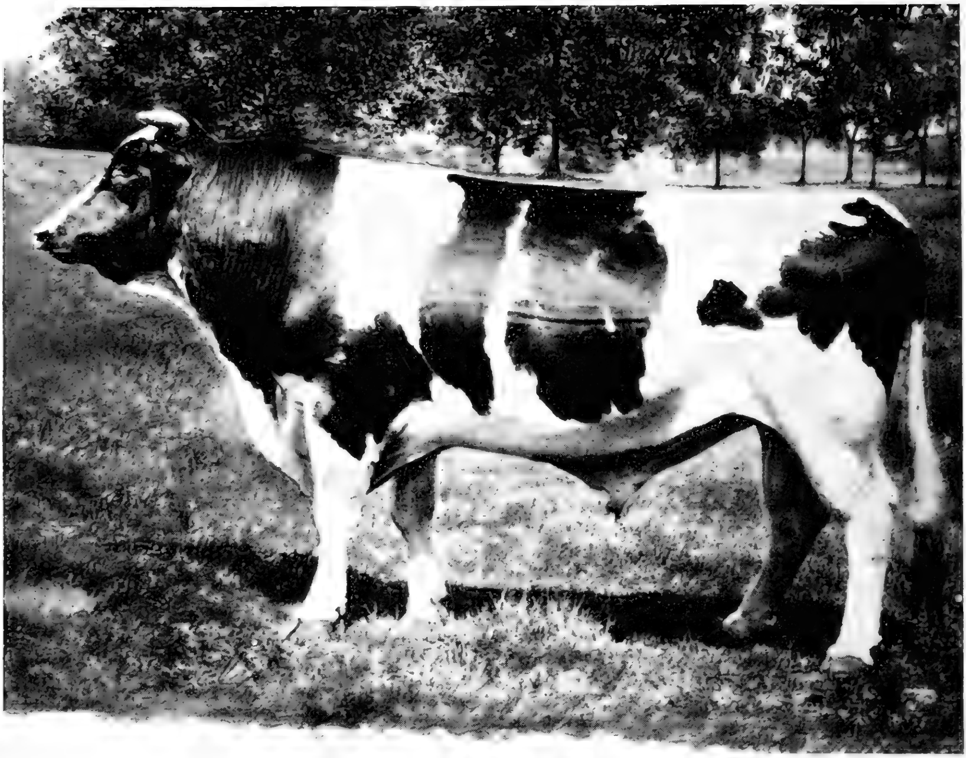
AVERAGE DEGREE OF SPOTTING OF THE LIGHT SIRE'S DAUGHTERS

FIGURE 16. This daughter of King Model (Bloomingdale Model Ormsby Segis 598203), shows the average grade of his daughters by all grades of cows. She has 201 units of black (about twenty-one per cent) on each side of the body. In all three bulls studied, the average color of offspring was intermediate between the grade of the sire and the avearge grade of the dams. Photograph courtesy of Bloomingdale Farms, Somerville, N. J.

least. Because of the small number of recorded offspring which could be obtained from any one female, it did not appear profitable with the time at our disposal to attempt to determine the genotypes of individual females, although we realized that this would eventually be a necessary step.

Methods of Obtaining Data

All of the evidence used in this study was obtained from the individual registry certificates in the office of the Holstein-Friesian Association at Brattleboro, Vermont. These certificates contain among other things the registry number of the animal, registry number of sire and dam, and a sketch of the spotting of the animal drawn on a standardized diagram. The accuracy of the parentage records of these animals need not be questioned since this is a matter of considerable concern to the registry office and is checked by them. The sketch of the animal is made by the breeder and although checked by an independent observer, is admittedly an approximation. It is sometimes rechecked when the animal is sold and a new registry certificate made out; and in such cases the agreement of the two records is reasonably good. The original sketches are nearly all made from young animals and some variation from this is to be expected when the same animal is resketched after attaining full size. The officials of the



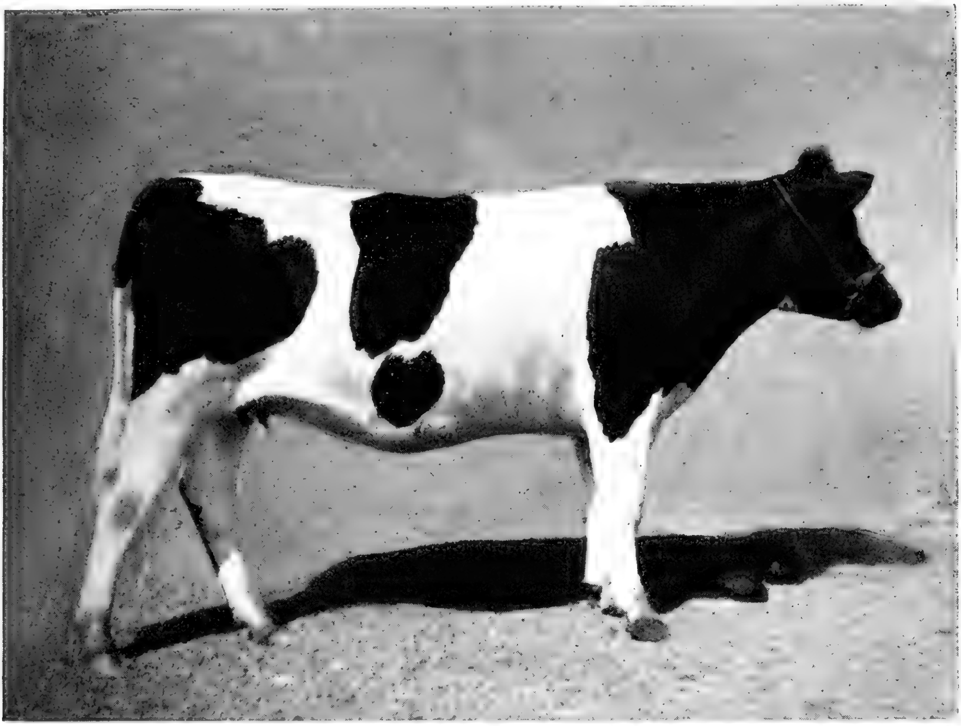
THE MEDIUM SIRE

FIGURE 17. King of the Pontiacs has about 350 units of black and although medium in appearance he bred more like a dark bull which was a hybrid, carrying latent factors for the lighter grades of spotting. This famous sire has 280 registered daughters. Bred by Stevens Hastings Co., Lacona, N. Y. Photograph courtesy of Mr. Stevens and the Holstein-Fresian World.

registry office believe the sketches to be fairly accurate on the average. The error in estimating the amounts of black and white present in the coat is probably not over five or ten per cent.

The spotting of each side of the animal is sketched separately on a standard profile diagram. Our method was to trace each sketch on onion skin paper. We then prepared a duplicate blank diagram on fine co-ordinate paper. The area occupied by the profile diagram was about 950 squares. The extent of the black and white spaces on each animal could then be estimated by applying the onion skin sketch to the ruled diagram and counting the number of squares covered by the black and white areas. This was done for both sides of all animals used in this study. The results for each estimation were then expressed as the number of units or squares of *black* on the animal. An all white animal would then be grade 0, while an all black one would be 950. The very light bull in Fig. 15 is of grade 50. The units in this case are 950ths of the total profile area of the animal, or practically per milles. Dividing each grade by ten reduces it roughly to per cents. Thus King Model (Fig. 15) is of grade 50 or roughly 5 per cent black.

The spotting grades of 294 animals are used in this study, divided as follows:



AVERAGE DARKNESS OF MEDIUM BULL'S OFFSPRING

FIGURE 18. Alcartra Johanna Korndyke 415274 shows the average grade of the daughters of King of the Pontiacs when mated to cows of all grades. The cows with which King of the Pontiacs were mated averaged 200 units (about twenty per cent) darker than the cows with which the other two bulls were bred. Photograph courtesy of the Bloomingdale Farms.

(1) A light bull (King Model) Figure 15:

46 cows mated to King Model and 50 offspring (25 males 25 females) resulting from these matings, including one pair of twins and two offspring each from three cows.

(2) A bull of medium grade (King of the Pontiacs) Figure 17:

49 cows mated to King of the Pontiacs and 49 offspring (25 males and 24 females) resulting from these matings.

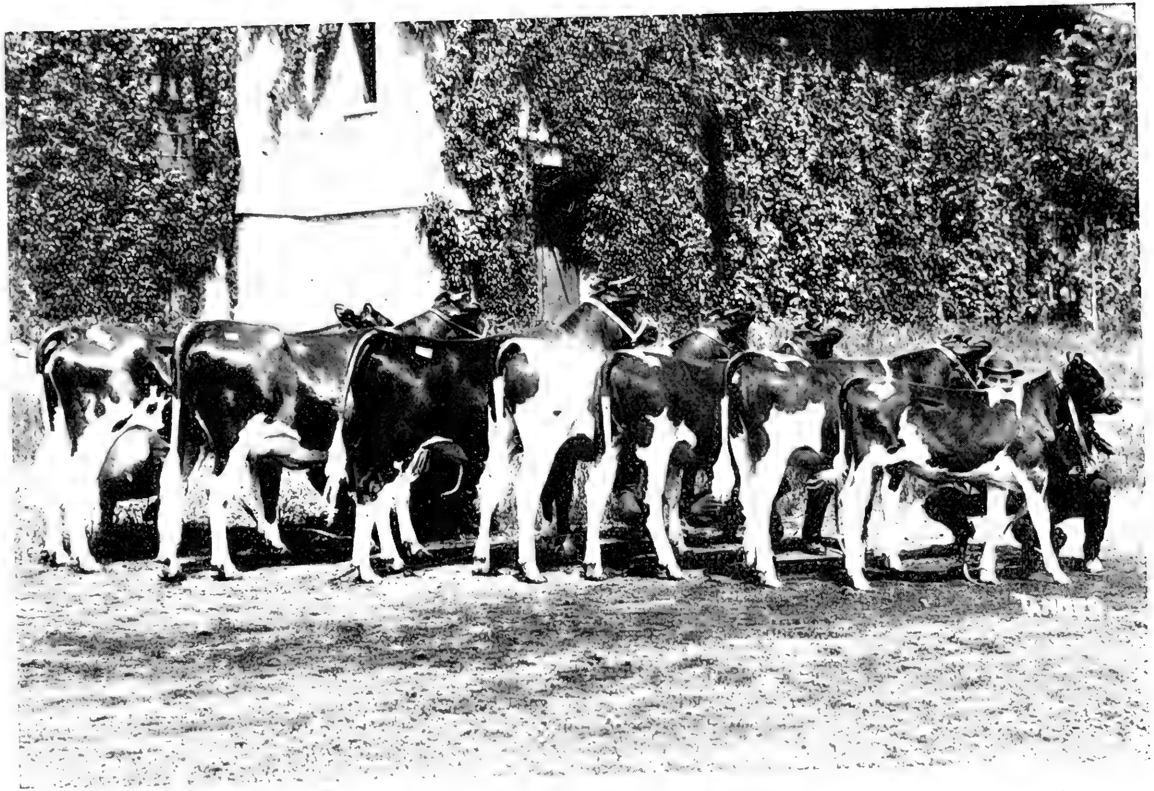
(3) A dark bull (King Pietertje Ormsby Piebe) Figure 20:

47 cows mated to King Pietertje Ormsby Piebe and 50 offspring (25 males and 25 females) from these matings, including 1 pair of twins and two offspring each from two cows.

The cows which had been mated to each bull were chosen by serial registry numbers in order that a random sample in respect to spotting might be secured. In order to secure an equal number of male and female offspring, the dams of the first twenty-five offspring were chosen as dams of female calves and the second twenty-five as dams of male calves.

Analysis of Data

In order to simplify the treatment of the data, we first determined the correlation between the amounts of black on the two sides of the body for



OFFSPRING OF THE DARK BULL

FIGURE 19. By cows of all grades, having an average of 353 units of black, King Pietertje Ormsby Piebe produced calves having an average of 638 units of black. Most of the calves are distinctly dark, but the presence of lighter individuals indicates that the bull is heterozygous for spotting characters, and carries factors for the lighter grades of spotting, concealed by the dominant darker colors. This group of King Pietertje's offspring sold at an average of $5,030, a strong argument for raising pure-bred cattle. Photograph courtesy of Hargrove and Arnold, and the Holstein-Fresian World.

THE DARK BULL

FIGURE 20. King Pietertje Ormsby Piebe 16594 has 900 units of black and only about fifty units of white. This is probably the dominant type of spotting in Holstein cattle, although this animal is not genetically pure for his spotting characters (see Figure 19). He is the world's highest yearly record bull for both butter and milk production. Owned by Hargrove and Arnold, Norwalk, Iowa. Photograph courtesy of the Holstein-Fresian World.

all animals used.[2] This correlation was found to be very high ($r = .971 \pm .002$). There was almost perfect agreement between the amounts of black on the right and left sides indicating that we were probably dealing with a general variation of black pigment present and that a description of one side of the body could be used with almost perfect accuracy as a description of the total amount of black pigment in the whole coat. Thereafter we used only the amount of black pigment on the *left* side as the spotting grade of the animal.

We next determined the gross amount of variation in spotting for the whole series of 142 dams, since these were taken as a random sample of the breed. These cows ranged in amount of black from about grade 10 (about 1 per cent black) to about grade 925 (about 92 per cent black). The small amounts of black in the lowest grades were centered principally on the head and particularly about the eyes, while in the darkest grades the small amounts of white appeared on the lower legs and along the underline. The absence of the extremes of self white and self black is due to the requirement of the association that animals eligible for registry shall be black and white. The variation appeared to be symmetrical and continuous from the lightest to the darkest grades. The mean grade of this random sample of cows was 433 units (about 43 per cent black) or slightly less than the mean of the possible extremes (475 units). This is perhaps due to a sexual difference since it is in-

[2]In this correlation and wherever biometrical methods were used we grouped the individuals in classes of 50 units, viz.: 0-49 units of black; 50-99 units, etc.

dicated below that females are probably somewhat lighter on the average than the males. The standard deviation of amount of black was 265 units while the coefficient of variation was 61 per cent. It is evident then that the spotting of these cows is extremely variable.

We then compared the two sexes in amount of spotting, using the offspring group in which the number of males and females was equal. The mean of all males was found to be 555.4 ± 22.9 units, while the mean of all females was 388.0 ± 20.8. The difference in mean grade was 67.39 ± 30.86, or slightly greater than twice its probable error which can hardly be accepted as statistically significant. We believe, however, that in a larger sample the males would be found to average somewhat darker than the females, and that this sexual difference accounts for the fact that the random sample of dams was somewhat lighter than the mean.[3] This probable sexual difference does not affect the conclusions which follow, since these are based on averages of equal numbers of male and female offspring.

We next compared the mean grades of the offspring of the light, medium and dark bulls. The results of this comparison are given in Table 1. The most obvious fact shown by this table is that the offspring of the three bulls which differed considerably in darkness, themselves differ in darkness in the same way as their sires. The progeny of King Model (Figure 15), a very light bull, are much lighter on the average than the offspring of King Pieterje (Fig. 20), a very dark bull, although the dams of the two lots were of similar darkness. The light bull produced light calves; the medium bull produced calves of medium darkness and the dark bull produced dark calves. The amounts of influence of the various sires on their offspring cannot be measured accurately by this method, for the group of cows with which each bull was mated did not prove to be of the same mean grades, although the method of random choice was designed to avoid such differences. The most serious departure in this respect is in the cows mated to the medium bull, King of the Pontiacs, which proved to be 200 units (20%) darker than the cows mated to either the light or dark bull. All groups of females, however, fall within the medium class and the mean grades of their calves clearly show the influence of the sire and point to the heritability of differences in darkness.

Each male, however, differs in darkness from the average of the females with which he was mated. The calves produced are in each case intermediate in darkness between the sire and the average of the dams. The average grade of the calves is very near to the average between the sire and dam as shown by the following tabulation:

Spotting of Sire	*Light*	*Medium*	*Dark*
Av. Grade of Parents..	220	449	623
Av. Grade of Offspring	201	430	638

This might be taken as evidence of a purely blending type of inheritance in which dominance was absent, such as that which characterizes some cases of size inheritance. But mass statistics alone are inadequate to establish the mode of inheritance, since individual differences are extinguished by averaging and we know now that in-

[3]An interesting parallelism is thus established between the spotting of Holstein cattle and the piebald spotting of guinea pigs. Wright (*Proceedings National Academy of Sciences*, 6:321, 1920) found that the males of all the piebald stocks of guinea pigs which he had observed had about seven per cent more color than the females. In the preliminary figures given above the Holstein males are darker than the females by about the same amount. In both animals sex, as Wright has suggested, acts as a modifier for the colored and white pattern, which is inherited independently of sex. A comparison of spotting in the males and females of two inbred stocks of piebald mice reveals no significant sexual difference (unpublished data).

heritance is in general a matter of individual differences and separable traits. We may, however, conclude that the average *result* of crossing animals of different grades is the production of offspring whose *average grade* is intermediate between those of the parents. This is purely a statement of average facts and not an explanation of the inheritance.

We next attempted to determine the differences in the hereditary contributions of the different sires used by measuring the resemblance or correlation in spotting between individual calves and their dams for each progeny group separately. We reasoned that if the germ cells of the sire contained factors recessive to those of the dams then there should be a high degree of resemblance between dam and offspring, because the contribution of the sire should not be visible in his offspring. If, on the other hand, the sire contributed dominant factors, the resemblance between offspring and dams should be altered (correlation lowered) by the "interference" of the factors from the male. If there were no dominance, the contributions of sire and dam to the offspring should be of equal effect and variation in the dams should be accompanied to some extent by variation in the offspring, resulting in low correlation between dams and offspring. This reasoning we believe to be sound, but in our own case many practical difficulties stand in the way of a direct application of this method. Chief of these is the fact that for at least two of the sires used we cannot be certain that the germ cells produced are alike; we have no good evidence that they are homozygous. Another difficulty is the fact that all three sires were not bred to exactly the same types of cows. The cows to which the light and dark bulls were bred are roughly of similar darkness, but the cows to which the medium bull was bred were darker than the other two groups. The most profitable procedure is therefore to compare the degree of dam-offspring resemblance in the progenies of the light and the dark sires.

The dam-offspring correlations are given in the last column of Table 1. There proved to be a high correlation ($r = +.61$) between the dams and offspring of the light bull (King Model) indicating that the factors contributed by this male were probably recessive to those of the dam. If the coat patterns of the offspring were determined wholly by the heredity of the sire and dam, then the contribution of the light sire has much less visible effect on the coat character of the offspring than the contribution of the darker dams. This last assumption is, however, probably not justified since some non-heritable variation exists.

The correlation between dams and offspring of the dark bull, while undoubtedly significant, is only about half as great ($r = +.34$) as the correlation between dams and offspring of the light bull. The relative importance of dam and sire is here reversed, the dark male having the greater determinative effect, indicating dominance of the factors contributed by him.

There proved to be no correlation between the dams and the offspring of the medium bull indicating possibly equal determinative effect of the contributions of sire and dam. Because of the probable independent segregation of spotting factors taking place in this cross (see below) indicating a heterozygous genotype for the male and many of the females in these matings, and because of the difference in mean grade of the mated cows we prefer to draw no conclusions from this correlation.

Accepting this as partial evidence of the dominance of the darker over the lighter grades of spotting, we next attempted to determine whether there was any clear evidence of the segregation of factors affecting the amount of spotting. We divided all animals used into three groups, classifying as "light" those with from 0 to 249 units of black; as "dark" those with 700 to 949 units of black; and as "medium"

those with 250 to 699 units. These divisions were not wholly arbitrary since the division points appeared to be regions of somewhat lower frequency in the whole distribution. We then listed the results of all matings within and between these groups, and have arranged these data in Table 2.

The cross of light by light was found to give practically all light. The two medium animals recorded were in one case a very light medium (250 units of black) which might easily have been placed in the "light" group and in another case a medium (450 units) whose dam was a cow with broken spotted areas distributed over the whole surface of the coat. The actual amount of black on this cow was 200 units, left and 250 units right. Because of the extended distribution of spotting she might have been placed in the medium class. We should make no great misstatement in saying that the lighter grades of spotting breed true to this condition.

The cross of light and dark animals produced principally animals of medium grade with a few light and a few dark offspring. On the hypothesis of the partial dominance of dark the appearance of light animals would indicate that some of the darks, including the dark bull, were heterozygous. The appearance of some dark offspring indicates that the dominance of dark may be nearly complete. Medium animals bred together produced principally medium calves with some evidence of the segregation of light and dark animals. Medium females bred to light males produced a preponderance of light calves and some mediums but no darks, while the medium male bred to light cows produced in addition two dark calves. Medium by dark produced principally darks and mediums with distinct evidence of segregation of some lights. Dark by dark produced few calves of which four were dark and one was medium. A general survey of the individual matings showed that with few exceptions the calves produced were generally no darker than the darker of the parents, making the case somewhat analogous to the inheritance of shades of eye color in man. The exceptions were the dark calves produced by the medium bull when bred to both light and medium cows. It is possible that the medium bull was of a dark genotype, although he was phenotypically medium. Certainly he bred more like a dark than a medium bull. In general then it appears that the light animals used were fairly pure for this condition, while both the medium and dark bulls were heterozygous. The results of reciprocal crosses were not always similar, there being usually an excess of dark animals in the offspring of the dark and medium bulls; the males appeared more "prepotent" in transmitting darkness. But with this small sample of animals tested no conclusions from this are warranted. The chief result of the evidence considered in this way is the demonstration of the segregation of the lighter from the darker grades, without the reverse phenomenon except in the case of the phenotypically medium bull.

Non-Genetic Variation

We have no good evidence on the amount of non-genetic variation in these spotting patterns, but it probably occurs to a degree. The best measure of it would be the amount of variation existing in identical twins; and we have been unable so far to assemble indisputable cases of identical twinning.

The recent data of Gowen[4] and of Lillie[5] indicate quite conclusively that identical twinning in cattle is extremely rare, if it does occur. Lillie finds in his Keller's and Tandler's cases (p. 52) only one certain case of identical twinning out of 126 cases of monosexual twins in which the number of corpora lutea in both ovaries

[4] Gowen, J. W. *Biological Bulletin* 41: 1-6. 1922.
[5] Lillie, F. R. *Ibid.*, 44:47-78. 1923.

OFFSPRING OF KING PIETERTJE

FIGURE 21. Notice how closely the calves resemble their sire, not only in amount of black and white, but in its distribution. A certain amount of non-genetic variation certainly occurs, but just how much is difficult to determine. Photograph courtesy the Holstein-Fresian World.

could be determined. Because of the tendency of originally separate chorions to fuse, the evidence from the conditions of the membranes at birth is not reliable, so that this method which would seem to offer a mode of attack on the problem of spotting inheritance, appears actually to be of no value. Gowen (loc. lit.) collected 1122 cases of twins in Jersey cattle and from the degree of resemblance in body markings between monosexual as compared with bi-sexual twins and sisters of separate births concluded (p. 5), "These facts all point to not more than a low percentage of identical twins in cattle if they exist at all."

Of the two pairs of monosexual twins in our series, one pair is alike in coat pattern, one member having

250 units of black left
150 units of black right

and the other

150 left
150 right

The members of the other pair are dissimilar, one being

200 left
100 right

the other

650 left
650 right

The second pair is from a cross of light by dark and shows segregation of light and medium; while the first pair is from medium by light and shows segregation of light from medium. In view of the facts cited above, the resemblances and differences of these twins are only such as might be expected to arise from segregation of spotting factors in individuals of separate birth.

Discussion and Conclusion

The results obtained from this study are chiefly of value in pointing out an interesting problem for which a greater amount of material is available than for any other problem of coat color or spotting inheritance known to us, and in indicating some of the methods by which it may be attacked.

The preliminary evidence is sufficient to indicate that:

(1) Differences in amounts of spotting in Holstein cattle are inherited, and amenable to selection even when this is practised on the male side only as in the present case.

(2) That the darker grades are probably partially dominant over the lighter grades.

(3) That segregation of factors determining the grosser difference in spotting occurs.

(4) That some degree of blending occurs, due possibly to minor modifying factors whose expression together with that of the major factor or factors may be obscured by non-genetic variation at present not measured.

(5) Because of the extreme rarity of proven cases of identical twinning in cattle it will probably not be possible to measure the amount of this non-genetic variability by the comparison of the spotting patterns of monosexual twins.

The present data cannot be used for measuring the number or the quantitive effects of the factors involved since in the absence of knowledge concerning the genotypes of the animals used, the proportions of offspring of various types can have little significance. There is every indication, however, that an exact interpretation can be arrived at through the collection and study of more data.

TABLE 1. *Average results of crossing bulls of different spotting grades with females of all grades*

Sire			*Mean Grade Units of Black*	*Standard Deviation (Units)*	*Coefficient of Variation (Percent)*	*Coefficient of Correlation Dams and Offspring*
King Model	Dams	46	392.39±24.91	250.50±17.62	63.84±6.05	.61±.06
(Light, grade 50)	Offspring	50	201.00±15.41	161.50±10.89	80.35±8.24	$\frac{r}{Er}$ =10.16
King of the Pontiacs	Dams	49	549.49±24.38	253.00±17.24	46.04±3.74	.05±.10
(Medium, grade 350)	Offspring	49	430.10±23.32	242.00±16.49	46.27±4.90	$\frac{r}{Er}$ = .50
King Pietertje Ormsby Piebe	Dams	47	353.73±24.50	249.00±17.32	70.39±6.91	.34±.08
(Dark, grade 900)	Offspring	50	638.00±23.66	248.00±16.73	38.87±2.99	$\frac{r}{Er}$ = 4.25
All Dams		142	433.80±14.20	265.00±10.61	61.09±3.23	

TABLE 2. *Results of crosses among Holstein cattle of various grades of spotting.*

Parents	*Offspring*			
	Light (0-249)	*Medium* (250-699)	*Dark* (700-949)	*Mean Grade Offspring*
Light ♂ × Light ♀	13	2	—	125.00 ± 81.68
Light ♂ × Dark ♀	1	7	—	431.25 ± 31.24
Light ♀ × Dark ♂	3	12	6	555.95 ± 33.85
Medium ♀ × Medium ♂	6	13	2	457.86 ± 32.38
Medium ♀ × Light ♂	20	7	—	175.00 ± 15.77
Medium ♂ × Light ♀	3	5	2	370.00 ± 50.98
Medium ♀ × Dark ♂	3	7	14	677.09 ± 34.21
Medium ♂ × Dark ♀	2	10	6	566.67 ± 37.12
Dark ♂ × Dark ♀	—	1	4	795.00 ± 56.11
Total	51	64	34	149

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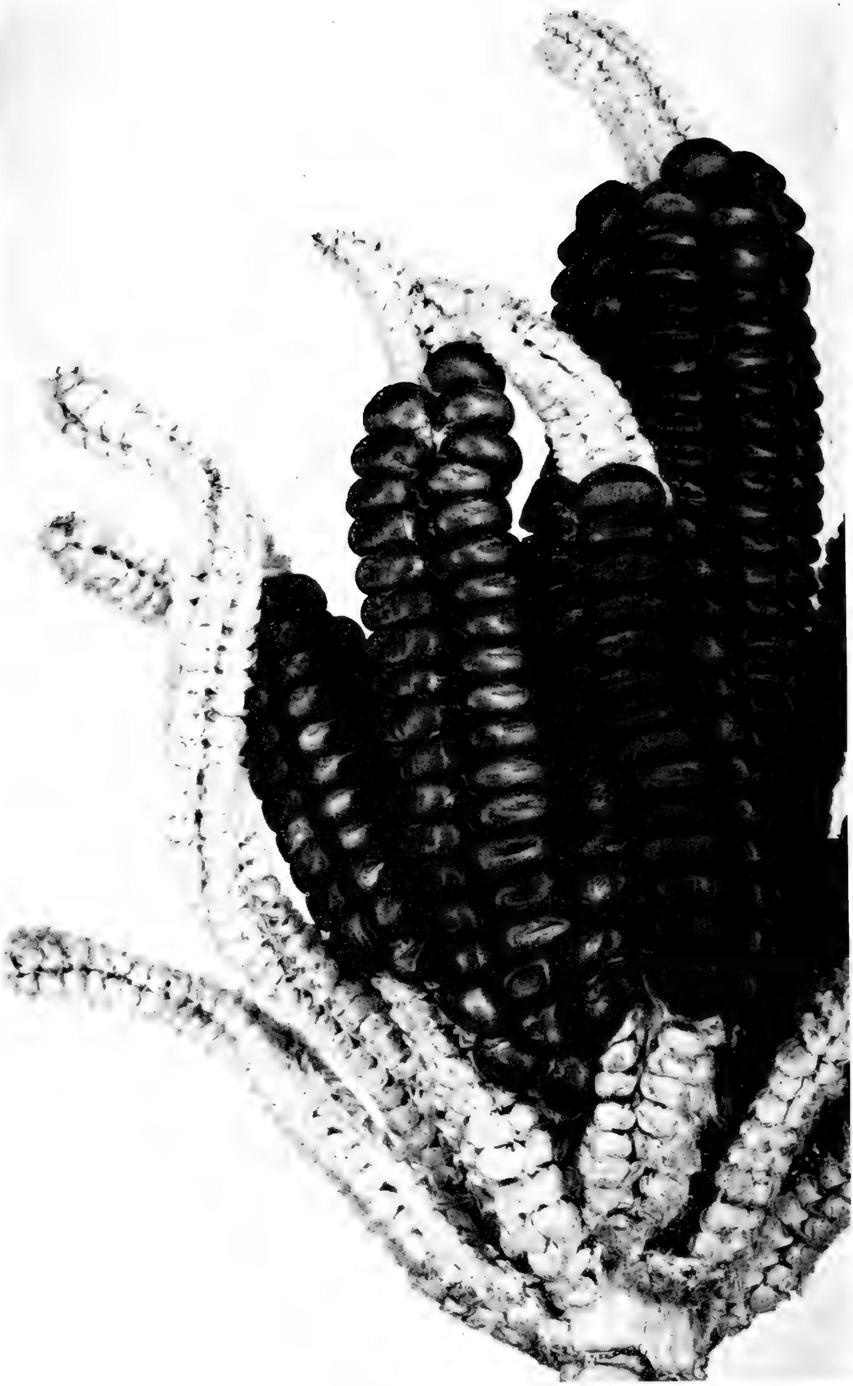


A BRANCHED EAR OF MAIZE—AN INHERITED ABNORMALITY

Many of the abnormalities thus far reported in Indian corn are inherited in a simple Mendelian manner, but this is partly because the cases of simpler inheritance have been studied first, and the more complicated problems deferred. The inheritance of this form of branched ears is not according to the usual Mendelian system. Mendelian ratios were not obtained and it was not possible to isolate a uniform branch-eared strain, or even to approach that condition. Continued self-pollination does not appear to increase the number of such plants, which are produced at a rate of about five normal plants to one bearing branched ears. The ear from which this strain originated came from a variety of maize grown by the Pawnee Indians. (Frontispiece.)

HERITABLE CHARACTERS OF MAIZE

XIV—Branched Ears

J. H. KEMPTON

Bureau Plant Industry

THE number of simple Mendelian characters reported for maize is increasing constantly and creating the erroneous impression that all heritable teratological variations result from changes in single hereditary units. Following the discovery of a new abnormality the customary procedure is to inbreed for several generations, propagating only those individuals which express the character in its most extreme form. After this treatment abnormalities which fail to behave as simple or comparatively simple characters when crossed with closely related normal individuals must bide their time until the mode of inheritance of the more simple characters has been determined satisfactorily. This procedure is quite logical and fully justified by the results, although it can but lead the reader unversed in genetic practice to believe that the inheritance of the majority of the most striking characters is quite simple.

The present paper deals with a character fully as striking as most of its predecessors in this series but differing from them in the mode of inheritance. This character is manifested by the production of seed-bearing branches at the base of the ear and clearly represents a reversion to a less specialized form. It is well known that the terminal panicles of tillers or suckers commonly bear pistillate as well as staminate spikelets and that all degrees of the production of seeds in these inflorescences exist, ranging from normal branched staminate panicles to inflorescences completely resembling ears, having no branches and producing nothing but pistillate spikelets on fully developed cobs. So varied are the inflorescences of suckers that in order to classify the different sorts we have established sixty types which represent fairly well the stages from the normal branched staminate inflorescences to unbranched ears. The suckers borne on different plants range in type from something resembling an upper floral branch or ear to a replica of the main stalk. The variations in the type of inflorescence clearly result from the attempt to adjust a bisexual inflorescence on a monoecious plant which normally has the sexes in separate inflorescences.

In view of the unstable condition prevailing in the character of the inflorescences of suckers it seems noteworthy that the character of the ear should remain so constant though separated from the suckers by but a few metamers and related to them through an unbroken series of buds. In all maize plants there is a section of several metamers with dormant buds which separates the pistillate branches or ears from the vegetative branches or suckers and presumably it is in this transitional section that the character of the inflorescence becomes stabilized in an unbranched pistillate form.

Types of Branched Ears

Five forms of branched ears are recognized, of which bearsfoot and ramose are the most common, these having formed the basis of theories of the origin of the ear. They are shown in Figures 1, 2 and 3.

A third form in which two or more entire and otherwise normal ears are united in a single inflorescence was found by Collins and Doyle at Tuxtla,

Mexico, where it is known by the name *Quachi,* a native word meaning twins[1] (Figure 4). This style of branching also is inherited but owing to the extremely long season required for the growth of the variety producing it no accurate analysis has been possible. Seeds from the original open-pollinated ears were planted in southern Florida and while the growth was unsatisfactory the nubbins produced ranged from normal unbranched cobs to those with as many as four branches of equal size. Recognized Mendelian ratios were not obtained and in any event, owing to the open-pollination of the parental ears the ratios could have little genetic significance.

A fourth form of branching which is of rather common occurrence especially in varieties of sweet corn, is a branch, or more rarely two or more branches, at the base of the ear inside the innermost husk (Figure 3). This branch is itself enclosed in several husks and has the form of a normal ear, usually with more than four rows and very rarely with well-developed seeds. The inheritance of this type of branching, though as yet not tested in great detail, seems very similar to that of the fifth form to be discussed.

The fifth form of branching consists of from one to many four-rowed branches at the base of the ear, usually with fully-developed seeds. These branches are naked but are enclosed in the husks which envelop the ear (Frontispiece). It is with this type of branched ear that the present paper deals, and for which the designation "branched ear" is proposed.

Origin of "Branched Ears"

In growing a large block of inbred varieties we have had the good fortune to self-pollinate an ear showing this latter type of branching. The original ear from which this variation descended was received from Melvin R. Gilmore, Curator of the Museum of the Nebraska State Historical Society. This ear was of a Pawnee Indian variety and like so many Indian varieties had eight rows of seeds while the plants grown from it produced many suckers or tillers. Seeds from the original normal ear were planted and produced thirty-eight normal plants. Of these, five were hand-pollinated. A self-pollinated ear from one of these five was planted the following season and eighty-eight plants were raised. Three of these plants produced branched ears of varying degree. The most extremely branched ear had eleven branches, all four-rowed, in addition to the central eight-rowed spike. This ear is shown in the Frontispiece, and its pedigree is given in Figure 5. Only the upper ear of the plant was branched but two ears borne on tillers were bifurcated at the tip.

As the pedigree shows, there have been four generations of self-pollinated, branched ears and as yet no progenies breeding true for branched ears have been obtained. This behavior is in marked contrast with that of the ramose type of branched ear or even that of the bearsfoot or fasciated form.

The amount of branching varies, though never approaching the ramose form but not infrequently the upper ear will bear one or more branches and the lower none. The tendency for the upper ear to be more branched than the lower one is a curious phenomenon in view of the nature of the abnormality. Thus the lower ears would be expected to approach suckers more nearly than would the upper ears and if there are to be differences between them in the amount of branching the lower ears should have more rather than fewer branches than upper ears. This tendency for lower ears to have fewer branches than upper ears has been observed in the case of intermediate ramose inflorescences and may be attributed to differences in metabolism. It is well known that the upper ear of multiple-eared plants, usually is the heaviest and as it precedes the lower

[1] Collins, G. N. and C. B. Doyle. Notes on Southern Mexico. *Nat'l. Geog. Mag.* March, 1911. Pp. 301-320. Illus.

ears in flowering it would seem to be the better nourished.

It seems not unreasonable to suppose that vigor would increase or favor a tendency to branch while severely unfavorable conditions certainly would result in the suppression of branches. However, if this were the whole explanation of the variability in branching, the general unfavorable conditions which caused suppression of branches should result also in a reduction of the size of the ear with the result that unbranched ears of progenies grown from a branched parent would be smaller than the branched ears in the same progeny. Such does not prove to be the case; in fact, the contrary seems to be true and if external environment is to be considered as a factor in the production of branches it must be assumed that this factor affects only branching rather than vigor in general.

While environment may be an important factor in the suppression or development of branches, adjacent plants in a row undoubtedly have a very similar environment and when one plant produces branched ears, and the next unbranched ones, the change must be in the nature of a threshold effect where small environmental fluctuations have acted in the same direction with factors controlling branching. If this be true then the branched progenies of unbranched ears, produced in progenies grown from branched ears, would be expected to have fewer branched-eared plants than the progenies grown from their branch-eared sibs.

An examination of the pedigree chart shows that the progenies from unbranched ears in the early generations had fewer branched ears than the progenies from branched sister ears but that in the later generations no such difference is maintained. In fact, the only unbranched progeny in the later generations, directly descended from the original branched ear, was from a branched-eared parent. There is little to indicate, therefore, that in the later generations the difference between the branched and unbranched condition is heritable and the failure to develop branches in this particular line must be attributed to accidents of development.

As the chart shows, five progenies were grown from the self-pollinated plants of the original sowing and with a single exception all the branched ears thus far obtained are descended directly from only one of these five progenies.

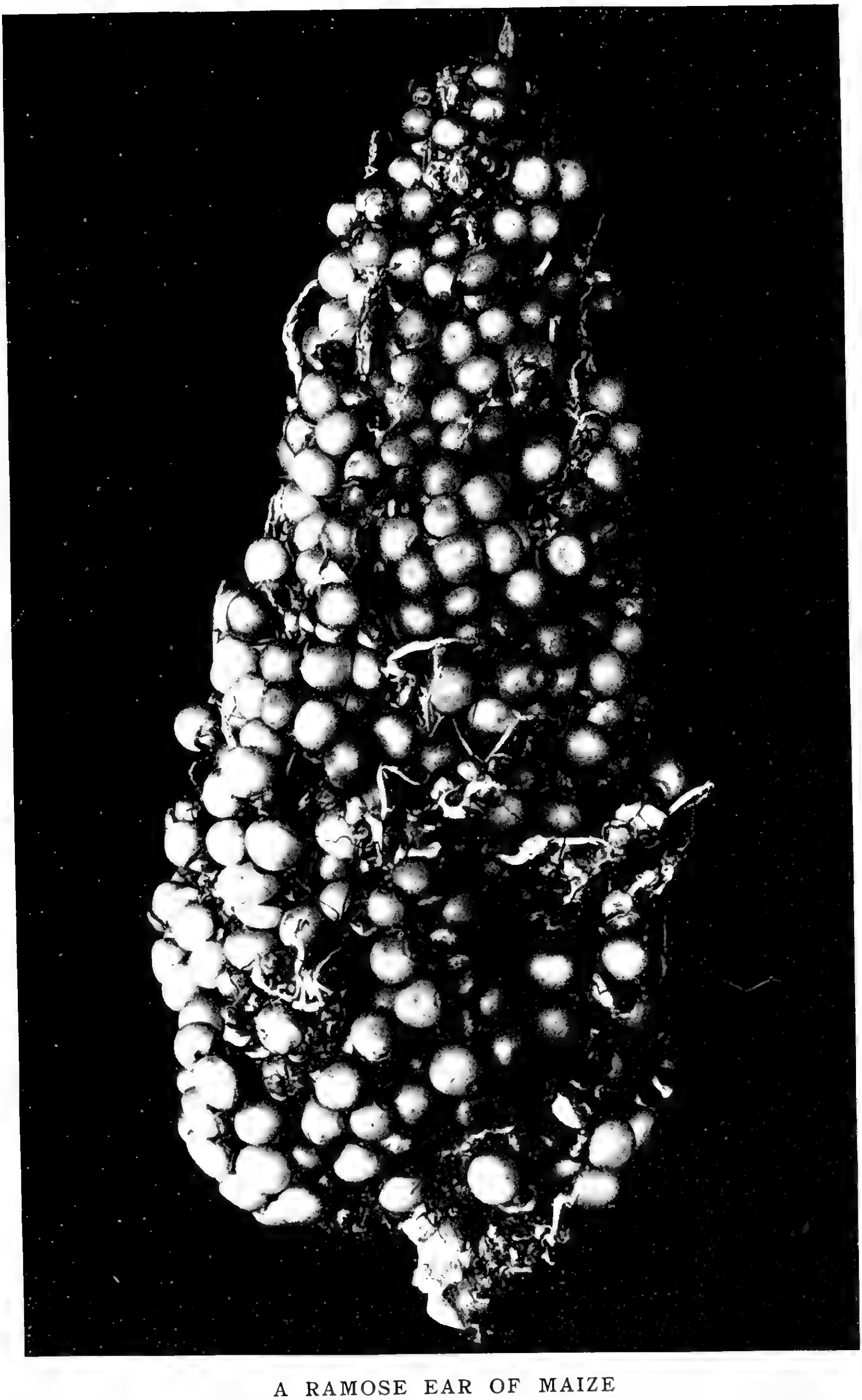
The exception appeared in the third generation of continuous inbreeding of the line marked X in Figure 5. The pedigree of this line is too extensive to publish, but 104 progenies have been grown, 103 of which have produced no branched ears and the other, one plant with a branched ear and twenty-six plants with normal ears.

Seventy-four progenies representing six generations have now been grown from the eighty-eight plants of the progeny that produced the first branched ears and from these progenies the following generalizations are possible:

The progenies of branched-eared plants have, with a single exception, always produced some branched-eared plants and since the percentage of such plants usually is low it is not certain that this exceptional progeny which comprised only eighteen plants, would not have given some branched ears had a larger population been grown. In this case if the expected ratio is assumed to be 4.8 unbranched to 1 branched (the ratio closely approximated in sister progenies) then the observed ratio of 18 normal to 0 branched plants departs from the assumed by an amount which would be expected to occur as the result of chance about once in fifteen times. In the entire pedigree there are thirty-five cases where progenies have been grown from self-pollinated normal plants that had branched-eared sibs. These progenies are not of the branched line shown in Figure 5 and if some of the unbranched ears of these progenies are heterozygous for branching two classes

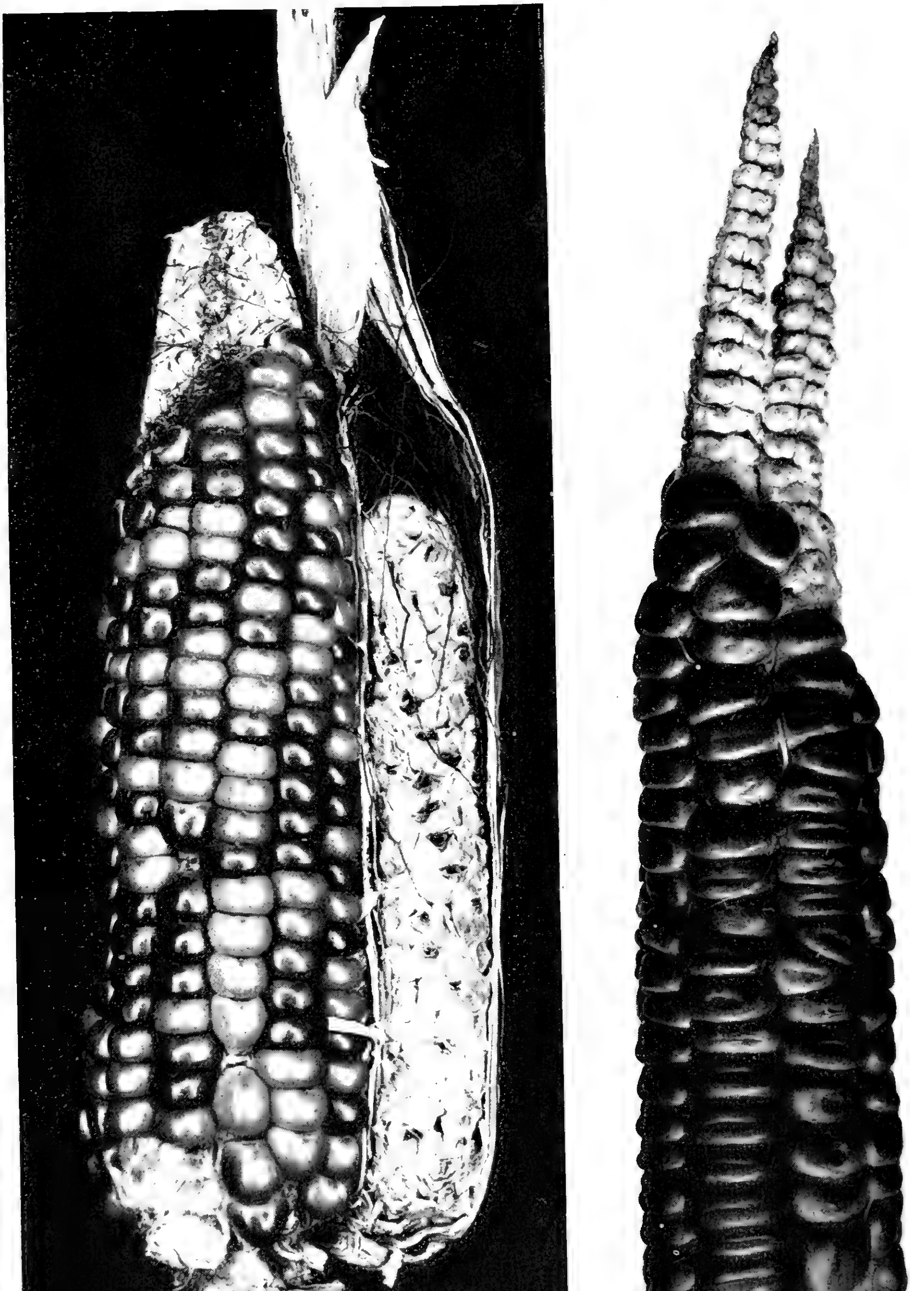
A "BEARSFOOT" EAR

FIGURE 1. Bearsfoot or fasciated ears are one of the commonest abnormalities of maize, and have furnished one explanation of the origin of the normal unbranched form of ear. Some authorities consider the many-rowed ear of maize to be the result of fasciation of the branches of an inflorescence such as shown in Figure 3 (right), and ears such as the above are considered to be examples of imperfect fasciation where the component members have divided or failed to unite.



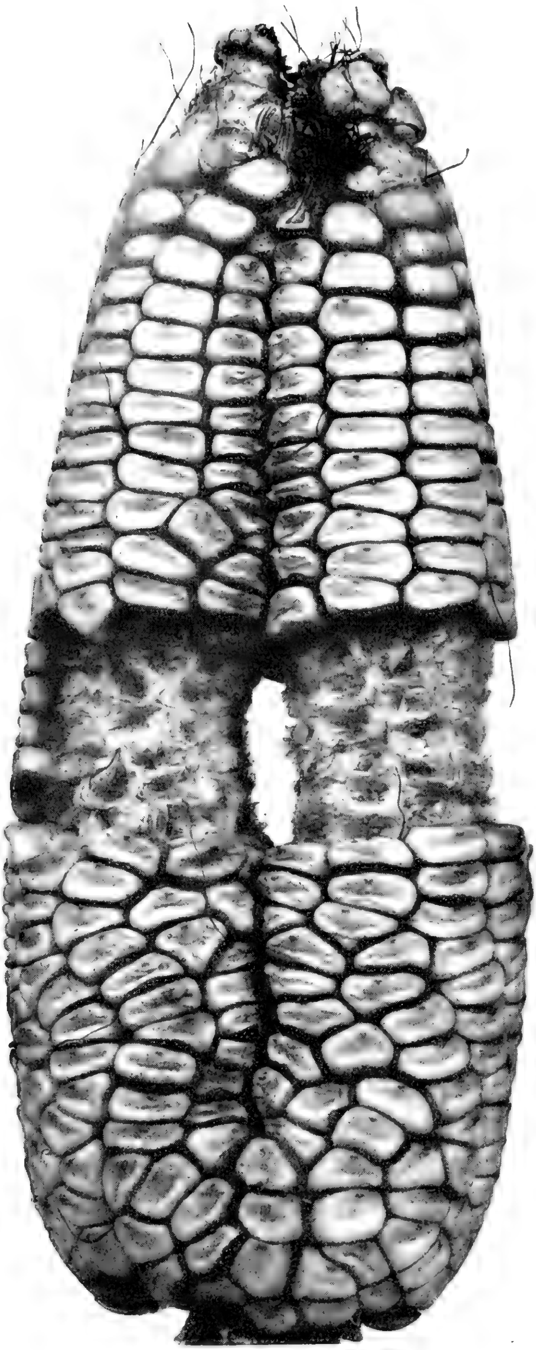
A RAMOSE EAR OF MAIZE

FIGURE 2. This abnormality consists of numerous branches which decrease in length from the base to the apex of the ear. The normal unbranched ear is considered by some authorities to have arisen through the reduction of the branches of such a ramose inflorescence to paired spikelets. The inheritance of this form of branching is relatively simple and its reappearance after hybridization with the normal form can be predicted with accuracy.



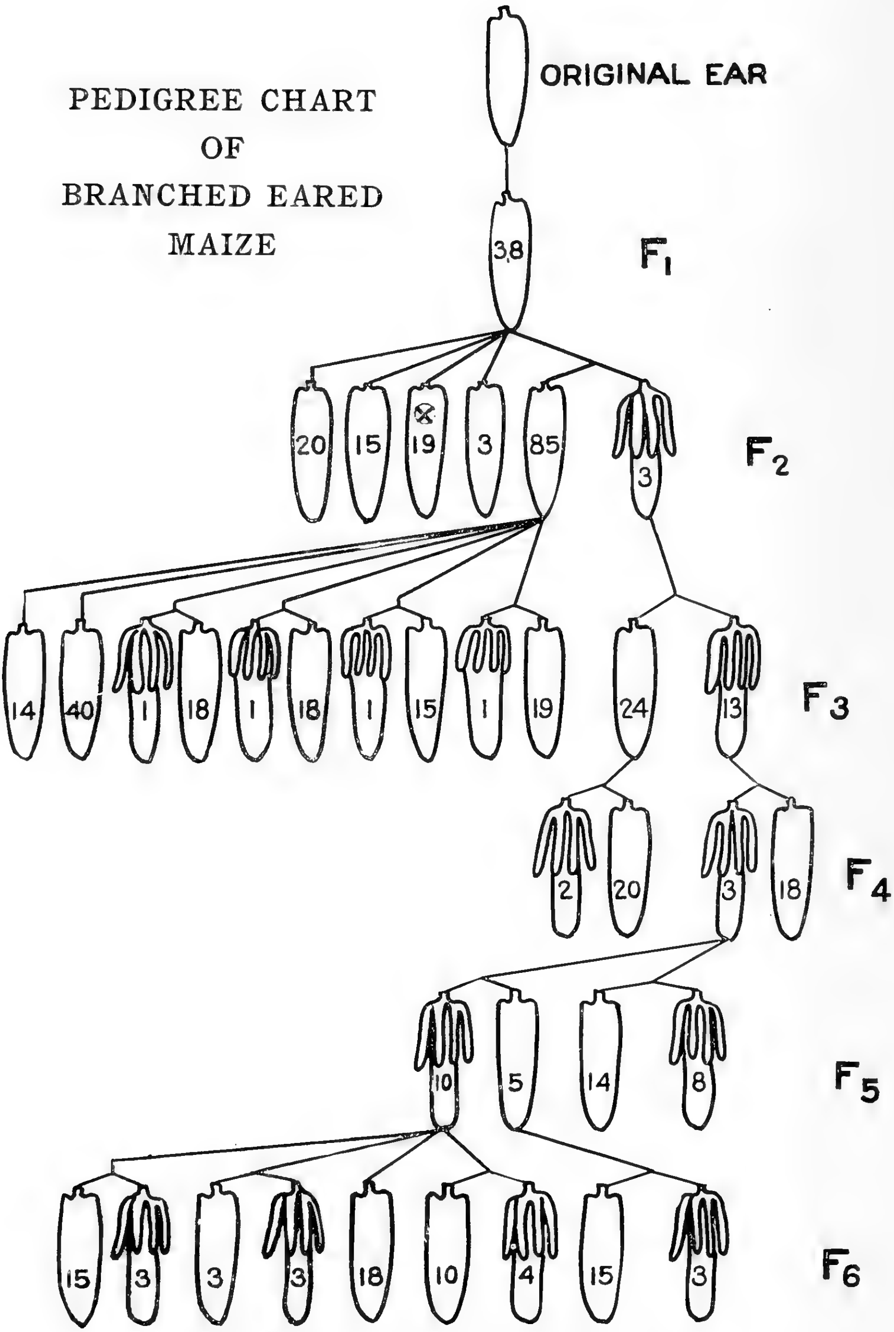
TWO TYPES OF BRANCHED MAIZE EARS

FIGURE 3. On the left is shown a form with branches enclosed separately in husks, like those of the principal ear. This type of branching seems to be inherited in much the same manner as that of the Pawnee Indian variety (Frontispiece). On the left is a partly bifurcated ear of maize, a type which strongly suggests that the eight-rowed ear is the result of the fusion of two four-rowed branches. This form of branching may be the same genetically as the "bearsfoot" branching shown in Figure 1.



TWIN EARS OF MAIZE

FIGURE 4. This ear was found at Tuxla, Mexico, under the name of "Quachi," a native word meaning twins, such double ears being common in the variety. This type of branching is known to be inherited, but the manner of inheritance has not yet been determined.



THE INHERITANCE OF BRANCHED EARS

FIGURE 5. The ears bracketed together are from the same progeny. In each case the number of plants bearing ears of the type shown is indicated on the diagram. Thus in F_6 the right-hand pair of ears represents a progeny of eighteen plants, fifteen of which bore unbranched ears while the other three bore branched ears. From the ear marked X in F_2 three generations of progenies were grown with continuous inbreeding; in all, 104 progenies. Only one of these progenies, in the third generation, produced a single plant with branched ears, along with twenty-six normal-eared plants.

of progenies are to be expected—those having some plants branched and those without branched plants. Of the thirty-five progenies, eight produced some branched-eared plants and twenty-seven only normals.

From the ratio of branched to normal-eared plants in the branched-eared strain shown in Figure 5 it seems clear that only about one-fifth of the plants in lines carrying the factors for branching exhibit the trait. If this be true for the Pawnee population as a whole, then the expected ratio of branched to non-branched progenies in a population from the self-pollinated non-branched plants with branched eared sibs would be 2.8 to 1, while the observed is 1 to 3.4. This latter ratio closely approximates that expected on the basis that branched ears result from the combination of four recessive factors and that the progenies tested were heterozygous for all of them, a condition which fails of support on other counts. With the small number involved it seems idle to speculate further on a possible factorial analysis especially since linked factors or even chromosome reduplication may be involved.

A single line from one of the eighty-five unbranched ears occurring later in the pedigree has been followed for two generations without branches but such cases require no especial explanation.

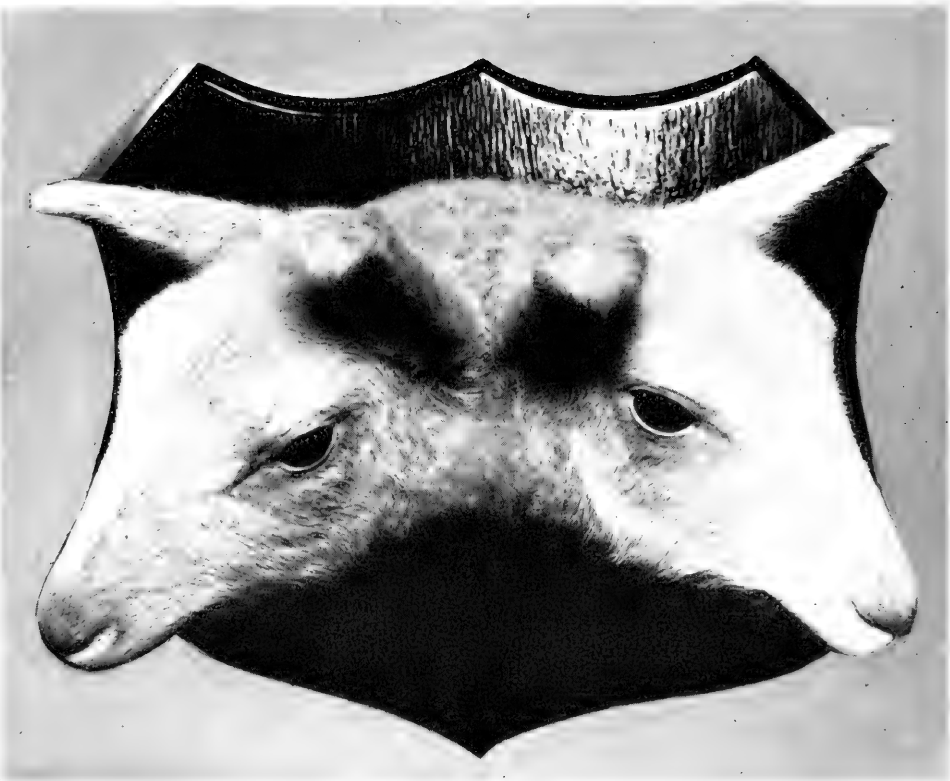
It is clear from the pedigree of the branched ear shown in Figure 5 that a line has been isolated from the Pawnee strain which can be relied upon to produce some plants with branched ears irrespective of the nature of the immediate parent. There can be little doubt that this type of branching is an inherited character for which the original branched ear was homozygous. Repeated self-pollination does not serve to stabilize the amount of branching and the percentage of non-branched plants does not decline. The variability in branching, therefore, cannot be attributed to the influence of hereditary modifying factors and must be considered as a phenomenon of expression rather than transmission.

Some of the progenies of unbranched plants having branched sibs related to but not of the above line plainly are heterozygous for the branched character while others seem homozygous for its allelomorph but the ratio of heterozygous to homozygous progenies is not orthodox. This behavior, however, indicates that the branched character is recessive to the normal form and permits the prediction that all self-pollinated branched ears will produce some branched-eared plants but the uncertainty with which such plants appear renders this character of little value in testing linkages. The fact must not be overlooked, however, that the mode of inheritance of branched ears is characteristic of a large class of characters which seem so delicately balanced as to require some special conditions in ontogeny for complete expression. That internal developmental factors, quite aside from external influences, play a large part in the expression of structural characters must be recognized and the accumulation of data on the inheritance of the more regular characters should not be allowed to obscure this fact. Such characters are to be expected in view of the complicated chemical reactions involved and should not be urged as examples of non-Mendelian inheritance even though in these cases the existence of stable hereditary units can not be demonstrated.

Mendelian Dominant, Or Maternal Impression?

A schoolmaster wrote the following criticism on the edge of a boy's report card: "A good worker, but talks too much."

When the father signed the report and sent it back the card bore in addition to his signature this report: "You should hear the mother."—*Judge.*



A TWO-HEADED LAMB

JOHN ROBERTSON

Tufta Harry, Orkney Islands, Scotland

THE accompanying photograph is of a preserved and mounted specimen of two heads of a lamb on one neck and united at the bases of the skulls. The local veterinary surgeon, Captain Eady, was called out to attend the case in the neighborhood on April 10th, 1922, and as far as could be ascertained the ewe showed no apparent abnormality on first examination, one head and two forelegs being quite normally presented in the passage. On further examination a second head could be traced to the same neck and, after careful munipulation, the lamb was delivered, breathing alternately from one head to the other. As the owner, Mr. Smith, of Winksetter, had no wish to keep it alive, the lamb was destroyed by the veterinary. The post mortem revealed a perfectly normal lamb, except for the two heads.

A second lamb was also delivered. This was normal and alive. It is curious to note that the same ewe was attended by Captain Eady on May 4th, 1921, and a dead lamb removed with some difficulty. Had this anything to do with the present freak of nature?

BIOLOGY IN HUMAN PROGRESS

Urbanism the Underlying Cause of Social Fermentation and Decay of Civilization

O. F. Cook

U. S. Department of Agriculture

THE time may soon come when civilization will be studied as a branch of biology, and compared with other social phenomena of the plant or animal world. The limiting factors of civilization are being sought by many writers in actual conditions and influences, instead of relying upon abstract ideas or believing that progress must run in fixed cycles of growth and decay. This is a constructive tendency that may gain for our civilization a sense of scientific foresight and powers of conscious adjustment, to avoid mistakes that have destroyed preceding systems.

Civilization is the world we live in, the aggregate product of human evolution, down to the present time. The tendencies of human evolution will determine the future of our system of culture and of our posterity, as the fates of other systems and other peoples have been determined in the past. War is the traditional destroyer of peoples, but military supremacy does not keep nations from decay or from suicidal courses, as is seen in ancient Rome or in modern Germany.

Limiting Factors in Human Development

Some of the early systems of civilization were self-limiting for agricultural reasons. The production of food could not be maintained after the forest vegetation was exterminated, because the grasslands that replaced the forests could not be cultivated by the primitive methods of agriculture. This would explain why many primitive cultures were abortive, and why the most ancient and enduring civilizations were those of Egypt, India and China, in the flood-plains of rivers where the soil is continually renewed. Some of the former centers of civilization are now entirely deserted, or the populations have changed so that the capable races of ancient times are only doubtfully recognized among the modern inhabitants.[1]

Urban deterioration of advanced races is another biological factor that helps to explain why civilizations are self-limiting. During the agricultural period the development of a race may be supposed to continue, since the more capable families are gradually improving their environmental conditions, and have better chances of survival. But when the period of urban civilization is reached the tendencies to race improvement are reversed. The capable families are attracted to the cities, where conditions are less favorable for normal individual development or for maintaining the capable stocks. Talented individuals of an advanced race are not more likely to leave descendants, but to form a smaller minority in each generation, as Galton recognized.

If the effects of urbanism were more clearly recognized as an agency for the elimination of less desirable stocks, the city might serve an important function in human development, but superior families that go to the city and deteriorate are a permanent loss to the race. The outlook for eugenic progress is small if the urban

[1] Cook, O. F. Milpa Agriculture, a Primitive Tropical System. From the *Smithsonian Report* for 1919. Pp. 307-326.

tendency to selective elimination of the more capable families is to remain dominant in our civilization. At least it is a hopeful sign that restrictive effects of urbanism on human development are being recognized more clearly. An article by Dean Inge on "Democracy and the Future," in the *Atlantic Monthly* for March, 1922, contains an acute analysis of the effects of urban industrial conditions as responsible for mental as well as for moral deterioration, and for marked anti-social tendencies in Europe and America.

More and more I am driven to the conviction that social unrest is an ineradicable disease of town life. The war is between town and country; between the countryman, who lives under natural and wholesome conditions, and the townsman, who lives under conditions which are neither natural nor wholesome. Allow me to quote from an American writer, Mr. Alleyne Ireland. "The average voter in a large town brings into politics a mentality utterly different from that of the country voter. It is the mind of the propertyless wage-earner; of the clerk, of the shop-assistant, of the day laborer; of a man herded with other men and profoundly affected by the herd-instinct; of a man of weak individuality; of a man who spends his working hours doing things for other people, and his leisure hours in having things done for him by other people; of a man whose life is passed in surroundings entirely created by machinery, and in circumstances where his free will is perpetually constrained by the contagion of an artificial environment; of a man who knows (or at any rate, of whom it is known) that, if he drops dead while at work, he can, in normal times, be replaced in an hour by another man who will do just as well."

Mr. Ireland goes on to show that such a man, whose whole existence is passed in the feverish occupations of earning wages and spending them, who is never brought into contact with the real origins of things, and is incapable of realizing the mesh of causation in which he is entangled, naturally looks to government to supply him with all that he needs, and to redress all his grievances. The two nations of which Disraeli spoke in *Sibyl* are not, as he supposed, the rich and the poor; they are the town and the country. And industrialism has thrown the balance of power into the hands of that section which, through no fault of its own, is stricken with an incurable malady.

This is what my medical friends would call a sombre diagnosis. It is very sombre indeed, as regards my own country, with its congested towns and limited rural area. It does not seem to be a disease which any form of government can cure. A Russian revolution would cure it in a way—by killing the patient. The evils of industrialism might, no doubt, be terminated by exterminating the industrialists. But the townsman of Europe and America has no mind to commit suicide, and unlike the Russian, he is capable of sane reflection. In America he will probably come round to the policy which has long found favor in Australia and New Zealand; he will stop immigration from the backward races.

New Zealand has escaped the evil of large cities, and has kept its population almost exclusively British. This policy has retarded the development of the country; and those who, like many Americans, are affected with a pathological worship of mere numbers, will think that the New Zealanders have not made the most of their opportunities. The case is arguable on both sides. Personally, I am disposed to think that the old American stock, which, until that disastrous Civil War, was the finest in the world, has been too much diluted during the last half century with infusions of inferior blood. But America, the most fortunate of countries, may make with impunity mistakes which would be disastrous in older nations.

I have made a diagnosis of the malady from which all civilized nations are suffering. I have suggested no remedy, because I do not know where the remedy is to be found. If the disaffection of the town-dweller continues to grow and fester, Democracy may fall, and civilization with it.

Effects of Environment

Nevertheless, the hope of finding a remedy is greatly increased when the cause of a disease is determined. If more of our economists and constructive reformers could see with Inge and Ireland that urbanism is responsible for social derangements, measures of improvement might be considered with better purpose. The moral and political dangers of urbanism have been recognized, of course, for centuries, and hope has been placed in moral and political remedies, but these are proving as ineffective in American cities, as in other parts of the world.

The effects of different environments upon the growth of plants and animals are being determined by scien-

tific methods, so that the best conditions and treatment may be provided, to facilitate the production of food and industrial raw materials, but human biology is an undeveloped branch of the science. Little consideration is given to the effects of the human environments, except to avoid the limits of starvation or disease. To raise a good crop of corn or cotton we know that the best seed must be selected and that the most favorable cultural conditions must be maintained, but the need of similar precautions in human development is neglected, even in the educational systems of advanced nations.

The effects of urban environment are like those of parasitism among plants and animals, which biologists treat as a degenerative condition. Compared with free-living types, parasites are inactive, inept, and infertile. In many different groups where parasitic habits have been adopted the general result is the same. Many organs and functions that in free-living groups are highly developed become weakened or are lost entirely among sedentary parasites. Cities are parasitic not only in being supported from the outside, but the arts of self-supporting existence are lost, as with other parasites.

The difference is not merely that the farmer works in the open air while the city cousin works in a shop or an office. The physical conditions may be important, but many other features must be considered in comparing the environments and determining their effects. Contacts with nature are enforced by the conditions of rural life. The change of seasons, the diversity of crops and weeds, and the care of different kinds of domestic animals, to say nothing of the wild flowers, birds and insects, make the life of the farm utterly different from the life of the city. The farmer's work is not a simple routine, but endlessly varied and requiring a continuous exercise of judgment to decide what must be done first, and to fit the different tasks together to the best advantage. An active farmer takes a vastly more complex, exacting and continuous responsibility than the urban worker who does the same thing every day, and has no responsibility when "off duty." The mind of the urban worker is formed by the uniform reactions of machinery rather than by the varied contacts with nature or with living things. "We take our industrial and commercial standards from the machine," as one writer says, and chiefly for the reason stated by Inge, that the urban worker is "a man whose life is passed in surroundings entirely created by machinery." The contacts would not be so restricted, if urbanism were not carried to excess.

The Basis of a Permanent Civilization

It is a mistake to suppose that civilization is a matter of cities alone. Agriculture is the constructive stage of civilization, urbanism the stage of deterioration and decline. The conditions that permitted the development of the arts and social adjustments to the point where cities of non-producers could be supported, were the conditions of primitive agricultural life, with families living separately upon the land and children associating with their parents so that the experience of the successive generations was accumulated. Many primitive peoples went prematurely into urbanism by living in communal dwellings or crowded settlements and restricted their possibilities of development, because the children of such communities herd together and have less association with their parents.[2]

The failure of ability to develop under the urban condition is seen in the waste of youth that each generation laments. Ability in the country may not be developed, but is likely to

[2] Cook, O. F. Definitions of Two Primitive Social States. *Journal of Washington Academy of Sciences,* Vol. II, No. 5, March 4, 1912.

THE RURAL ENVIRONMENT

FIGURE 7. "It is interesting to contemplate an entangled bank, clothed with many plants of many kinds, with birds singing in the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent on each other in so complex a manner, have all been produced by laws acting around us. . . . There is a grandeur in this view of life, with its several powers, having been originally breathed into a few forms or one: and that, whilst this planet has gone cycling on according to the fixed laws of gravity, from so simple a beginning, endless forms most beautiful and most wonderful have been, and are being, evolved." —*Charles Darwin.*

THE URBAN ENVIRONMENT

FIGURE 8. "The average voter in a large town brings into politics a mentality utterly different from that of the country voter. It is the mind of the propertyless wage-earner, of the clerk, of the shop assistant, of the day laborer, of a man herded with other man and profoundly affected by the herd instinct, of a man of weak individuality, of a man who spends his working hours doing things for other people, and his leisure hours in having things done for him by other people; of a man whose life is passed in surroundings entirely created by machinery, and in circumstances where his free will is perpetually constrained by an artificial environment, who is never brought into contact with the real origins of things, and is incapable of realizing the mesh of causation in which he is entangled."—*Alleyne Ireland.*

be transmitted, while either development or transmission of ability is less likely in the city. The ability that fails of transmission is a permanent loss to the race.

If urban populations did not deteriorate, but maintained a normal rate of increase, the cities might fill up, and a balance of urban and rural populations would be established. There would not be a continued draft upon the country, if the urban conditions were not destructive. But always there are inducements for capable men in the city, the recent arrivals competing successfully with the less energetic or resourceful natives of the city, and sending for their rural kinfolks to come in and share their prosperity, in the easier life of the city. The rural immigrant sees it as an advantage to him that the urbanites are less capable, not realizing that his own children will share the same limitations. Thus it is in the nature of cities to be calling always for more people, who go in and are consumed, the parents sacrificing their children as in the days of Moloch. The ancient rural gods were supposed to be satisfied with the blood of the first-born, but our urban dieties take the whole family. It is our immoral custom to sacrifice posterity to "prosperity." The limited urban environment and the selective draft upon the rural population work together to deplete the human stock. The race suffers as a whole, until the basis of civilization is destroyed. The "cycle of civilization" comes to an end, because the adjustments of a complex social structure are not to be maintained by a depleted and incapable population.

The urban environment is too restricted for the normal exercise, growth and satisfaction of the human instincts, senses and abilities. Full development of the physical, mental and social stature is seldom attained, and everybody is discontented who feels that he is being deprived of a normal existence. Rich urbanites may suffer from this feeling of inadequacy as acutely as the poor, and with as little understanding of the cause. Lack of practical judgment and aberrations of many kinds, in amusements, dissipations, narcotics, crimes and conspiracies are to be reckoned as symptoms of urban deterioration. Nervous prostration of the individual and radical upheavals of urban masses may be traced to the same underlying cause, the monotony and tension of urban existence. The danger of destructive mass movements at the present time is increased by the doctrine of socialism that ascribes all of the urban lesions to economic inequality. Because abuses exist it would abolish the institution of private property, and especially property in land. The socialist remedy for urban deterioration would make the city more actively parasitic upon the country and destroy civilization more rapidly. Only disaster could be expected through the control of the country from the city, which socialism would establish.

The course of history shows no remedy for urban deterioration and decay, no solution of the urban problem. Probably there is no artificial way to make good the effects of limited environment in restricting the development of the individual and causing the deterioration of the race through adverse selection. Urbanism is a dysgenic condition. "Great cities are the sink holes of the human race, the places where the blood deteriorates, sterilizes and runs out." Urbanism needs, of course, to be studied and its lesions carefully determined, but a phenomenon that is to be investigated in detail must first be recognized.

The American Ideal

America, fortunately, is not yet urbanized to the extent of the industrial countries of Europe. With us there are still living in the country many people who think and are learning practical ways of restricting the commercial parasitism of cities. This

effort is misunderstood, of course, by those who believe that the country owes the city a living, and also by those who think of farming as only one trade, one branch of "industry," and deserving of no special consideration. In reality agriculture is not a mere branch of civilization, but is the root of the whole tree, the root that has produced and now has to support all the branches of urban activity, along with the idle and parasitic elements that figure so largely in urban populations. It is beside the point to complain that the man who tills the soil is "compelled to bear the burden of the social structure," since there is no other way for the social structure to be supported. The tree must have its root, and the root must function if the tree is to grow, but parasites may distort or kill the tree, and our modern civilization is rather heavily infested. The branches are fringed with mistletoe, and many kinds of broom-rapes and beechdrops are sapping the root. Only as we assess the burden of urban parasitism can we begin to comprehend the true possibilities of a symmetrically developed rural civilization, which is the American ideal.

The purpose of founding a rural civilization, expressed with so much conviction by Washington and Jefferson, has been relaxed. We are tolerant and even boastful of our large cities, and take it for granted that sanitation and engineering improvements will avoid the deterioration of urban population. Our mental habit is to ignore the dehumanizing effects of urban industrial conditions and then to be surprised and horrified by the barbarism and brutality that appear, as in the relations of capital and labor. Germany was most scientifically urbanized and stood in the first rank of industrial and commercial nations, but staked all her attainments on a predatory war.

If we could accept the diagnosis that the urban state of mind, "the worship of mere numbers," is pathological, eugenics and other human welfare considerations would begin to figure in social and economic studies. Conditions and measures would be judged by the eugenic standard of improvement of the race. We would see that the city as a human environment is a mistake, and the question of abating the urban malady of civilization might be approached on constructive lines. One of the first steps would be to develop a better system of education, so that people would not be trained merely for the city, or for a "semimonastic" existence with late marriages and few children. Some talk there has been of country life education, but little of the reality as yet, for the educational value of country life has still to be recognized by the urban specialists who dominate the educational profession.

The other problems would be solved if more of our capable young people became intelligent enough to remain in the country. The adverse selection will go on as long as the schools are procurers for the city. Thousands of urbanized teachers are telling the children every day, even in rural schools, that the real life is in the city. To fire the mind of youth with the idea that the great prizes of life are to be captured in the city is essentially immoral, and must be condemned and counteracted as a betrayal of the race. Undoubtedly the life of the city often is much easier than that of the country, but certainly the ease and luxury of the city are not the highest ideals, and urbanism for the race is clearly suicidal.

GLANDS AND THEIR FUNCTION

A Review

GLANDS IN HEALTH AND DISEASE, by BENJAMIN HARROW, Professor of Physiological Chemistry at Columbia University, Pp. 218. Price $2.50. E. P. Dutton & Co., New York. 1922.

THIS little book of 218 pages contains a large amount of information in compact and readable form. It is intended as a popular exposition of the important field of the glands of internal secretion in their relation to bodily function and growth. The author has made a sincere effort to bring the subject within the grasp of the general reader and has for the most part been successful, although the subject is one through which it is most difficult to steer a straight course, when it comes to the problem of popularization. He is, above all, to be commended for his sanity and for his stern refusal to be enticed into sensationalism however well it might strike the popular fancy. This scientific attitude is the keynote to the book. There is also a very useful bibliography that will prove of value to many.

He gives a very lucid discussion of the nature of the endocrine glands in general, explaining the manner in which they function and dealing with such timely questions as their relation to vitamines. Very properly most attention is given to the thyroid, pituitary, pancreas, the germ glands, and the adrenals. His treatment of the thyroid gland is typical of the scope of the work. He describes its location, considers thyroid deficiency diseases, deals with the effects of oversecretion, and then proceeds to a discussion of the general principles of metabolism and the way in which the thyroid gland is involved. The more important lines of experimental work are discussed and an account of the biochemical aspects of the gland concludes the chapter. Throughout he makes specific reference to the work of various authors—a necessary treatment in a subject of conflicting views such as this. The chapter on the pituitary gland is handled in much the same style, and the same may be said of the book as a whole.

It is not surprising that in a subject so new and so full of conflicting opinions the author should lay himself open to criticism here and there. If only for the sake of conscientiously playing the part of reviewer we may offer a few criticisms. For instance, he says. "The pituitary body like the thyroid consists of two parts, two lobes." Not only in this but in later statements he shows ignorance of the more recent work in which the intermediate lobe and the pars tuberalis portions have been added to our knowledge of this composite gland or rather collection of glands. In any case the comparison with the homogeneous thyroid is rather unfortunate; but this is merely a fault of expression, because he discusses most fully and entertainingly the differences in function betwen the anterior and posterior lobes.

We can look with tolerance on such misuse of words as that of calling the production of ova by the ovary a process of secretion. In the chapter on the relation of the ductless glands to one another one might take issue with the statement that "removal of the thyroid gland causes enlargement of the pituitary and *vice versa*." The removal of the thyroid gland does cause hypertrophy of the *anterior lobe* of the pituitary gland, but the removal of the pituitary gland causes a reduction in size or even atrophy of the thyroid gland. We must take exception

to his statement that "castration does not seem to have much influence on the thyroid gland." Koch has shown that it becomes very small in castrated members of the skoptch sect in Russia and Roumania.

The author gives a very good account of the interesting rejuvenation experiments by implantation of germ glands, vasectomy, and use of X-rays, and gives a fairly full discussion of the work of Varonoff, Steinmach, and others. He might well have mentioned the interesting work of Dr. Stanley of the California State Prison at San Quentin.

Dr. Harrow also presents an interesting and well balanced account of the controversy betwen Cannon and Stewart upon the response of the adrenal glands to emotional excitement. He makes a well justified attack upon the extremists who so strongly urge the claims of organotherapy.

In this righteous war against sensationalism and quackery in which all lovers of sanity and truth bid him "God speed" he may now and then unjustly chastise thoroughly "law abiding" scientists as when under the heading *A Bit of Fancy* Dr. Harrow quotes some highly spiced newspaper accounts of the New York meetings of the International Congress of Eugenics, as they were reported at the time. The reports were quite wierd enough as all will agree; but a careful reading of the two volumes of published proceedings of the meetings fails to reveal the erratic statements attributed to the worthy scientists. Dr. Harrow in his eagerness to defend truth and sanity should not allow himself to be drawn into a sham battle with men of straw created by even "one of New York's very respectable newspapers." It is rather disconcerting to have a scientist side with the public press in its ribald laughter at the fancied vagaries of scientists. Heaven knows scientists have enough real vagaries to answer for. All this grows out of the author's healthy and very praiseworthy attitude of critical skepticism and he deserves the highest praise for sparing us the mass of half-baked wild hypotheses that some recent writers of books and quasi-popular articles have foisted upon a gullible public. So we say "all strength to his arm even though he may now and then hit an innocent and highly respectable scientist."

The author has given in his preface a warning of his critical attitude in the following readable passage:

> Monkey glands; clever men and stupid ones; glands as the cause of crime; the origin of races; the mentally unbalanced; many acute diseases; the bearded lady, the fat boy and the midget; all these and many more have been dealt with under the subject of glands of internal secretion. As in any subject that fires the popular imagination, fact and fancy have been mixed—several drops of fact have been diluted with many drops of fancy. The achievements, judged by rigid scientific standards, are no more than modest but the possibilities are limitless. It is because of these vast possibilities that an imagination, not sufficiently tempered by self-criticism, is apt to enlarge a molehill into a mountain.

This is a fine attitude—the only point of view from which one can write a really worthwhile book on any phase of science. The need for such scientific caution is especially great in this field of work where the temptations are so enticing, and Dr. Harrow has given us an admirable book worthy of the highest commendation. It is a compact, up-to-date, and truly scientific exposition of this subject. For the most part it is a highly entertaining book. In places the beginner might get rather deep into technicalities, but the author has done all that one could expect him to do toward making this complicated subject understandable. He has carefully qualified his statements by quoting conflicting views of different authorities. While this may bewilder readers who demand dogmatic and sensational as-

sertions, the public should learn that science cannot deal with reality in that way. This book is an admirable example of scientific candor, accuracy, enthusiasm and restraint. We can only hope that it may be given the widest currency.

BENNETT M. ALLEN,
University of California
(Southern Branch)

The Economic Value of Pure Bred Cattle

Seventy-five per cent of the dairy bulls in use in the United States are either grades or scrubs. They are bulls from ancestry that has not been bred generation after generation for large and economical production of milk and butter fat. This fact, says the United States Department of Agriculture, accounts for the low average production per cow in this country.

In 1921, there were less than 80,000 pure-bred bull calves registered by the breed associations. But this probably does not represent half the pure-bred bulls born in 1921. The 80,000 or more that were not registered, in addition to a part of those that were registered, were probably slaughtered because their breeders were not able to market them profitably. This is because the average farmer is not yet convinced of the advantages to be derived from the use of pure-bred sires. If every pure-bred bull calf born in this country were raised, it would take a three or four years' crop of calves to replace the grade and scrub bulls (numbering approximately 600,000) that are being used in dairy herds. When it is considered that not all pure-bred calves are worthy of being used, even on grade herds, and allowance is made for the normal death rate and other factors that enter to cut down the number of pure-bred bulls raised, the above estimate of three or four years could safely be increased to five or six years as the time that would be required to replace the scrub bulls.

Only three per cent of our dairy cattle are pure bred, and the supply of pure-bred bulls would be wholly inadequate if the farmers of the country could only appreciate the benefit it would be to them to head their producing herds with pure-bred sires of good producing strains.

—*U. S. Department of Agriculture.*

Two Corrections

Owing to a typographical error in the notice of a paper on Campanula, by Lathouwers, in Vol. XIV, number 8, page 345, of this Journal, the last line of the first paragraph was carried over to the second paragraph, with resulting confusion. The second paragraph should begin as follows:

"In a pure line of *Campanula medium* a form called *monantha* appeared. . ."

In the August 1923 Journal, page 209, a case of typographical "crossing over" occurred in the legend to the chart accompanying Dr. Castle's paper on the inheritance of webbed toes. In the last line of the legend it is stated that the character may be carried in the Y-chromosome. This should have read:

"Suggesting that the character is carried in the X-chromosome."

MENDELIAN INHERITANCE IN POULTRY

A Review

HEREDITY IN POULTRY, by REGINALD CRUNDALL PUNNETT, F. R. S., Professor of Biology in the University of Cambridge; Fellow of Gonville and Caius College, etc. Pp. 204; 12 pl; price $2.00. Macmillan & Company, Ltd., London and New York. 1923.

FOR over twenty years the domestic fowl has been the subject of experiments designed to discover, among other things, the mode of inheritance of specific traits. It furnished under the hands of Bateson the first demonstration of Mendelian inheritance in the animal kingdom, and has since contributed information on many of the more important general principles of genetics. Professor Punnett was one of the first to recognize its value as an experimental subject, and from his early association with Bateson to the present time, he has been intimately connected with the growth of knowledge about heredity in fowls. There is no one better qualified than he to write with interest and authority on the subject.

In compiling this book the author, as he tells us in the preface and the text, had a number of objects. He wished to summarize the progress of investigation, to provide a guide to past and possibly future work with poultry, and to present the problems involved in their relationship to the general problems of genetics. His presentation was influenced by an obvious desire to make his book of value to those with both a scientific and a practical interest in poultry. He is particularly aware of the need for impressing the practical man, who in the end supplies the funds for investigation, with the value of research into principles which may lay the foundation for applications to agriculture. The dominating, though unexpressed, object appears to be the introduction of the reader to the principles of Mendelism with illustrative material drawn from poultry breeding.

These objects although difficult to reconcile are in general fulfilled. The greatest success is attained in the last of the purposes mentioned and in the opinion of the reviewer, the book will prove of most value to persons interested in poultry who desire a simple presentation of Mendelian inheritance. Professor Punnett is a master of the art of simple, concise statement as is evidenced in his little volume on "Mendelism" and his article "Mendelism" in the Encyclopedia Brittanica, 11th Edition. He assumes but little familiarity with general biology on the part of the reader and proceeds from simple Mendelism through the more complicated subjects of reversion, multiple factor inheritance, sexual characters and sex-linked transmission to a short discussion of linkage. His illustrations are few, simple and well chosen, and they are in general comprehensible to the layman. The method of presenting each subject is the excellent one of giving first a simple example of the facts as known, then tracing the development of the theoretical explanation and finally, wherever possible, the indication of the application of the principles to poultry breeding. This method is well exemplified in his two chapters on sex-linked inheritance where after a theoretical explanation he shows the application of Pearl's hypothesis of the inheritance of fecundity, and clearly outlines the methods to be used for distinguishing the sex of young chicks by the use of sex-linked characters. He makes no mention of the chromosome theory of sex or linkage. In fact the word chromosome is not to be found in the index. This may be wise in

dealing with poultry where the chromosome situation is not clear, and it will be welcomed by those persons, who being unfamiliar with genetic theory and terminology, react to the word chromosome as a bull to a red flag. It is nevertheless a serious omission in a survey of any genetic subject.

The chief contributions of the book to a summary of progress in poultry genetics are in the chapters on plumage color and structural features, and in the bibliography of one hundred and forty-eight titles. This work of summary was much needed, and Professor Punnett has probably accomplished all that can be done at the present time. He has emphasized the incomplete state of our knowledge and the opportunity and need for further research, and this is generally the chief value of a summary of progress in science. In the text are also added numerous valuable observations of the author which had not been published previously, and which now become a part of the literature of the subject.

In the short readable treatment of the subject which Professor Punnett has given, omissions and simplifications are to the advantage of the reader not versed in genetics. The all inclusive and detailed nature of many books on scientific subjects is often the feature which restricts their appeal to purely professional readers. Without appearing to "write down" to the amateur, Professor Punnett has provided him with an introduction and a guide, while the annotated references will send him, if he is interested, to the original data. The geneticist will find few specific criticisms to make. One which will appear is the confusion of "sex-linked" and "sex-limited" traits (Cf Esp. p. 78). This distinction which has become fixed in American literature, is not clear either in this volume or in the author's previous book, "Mendelism." Chapter VI, on secondary sexual characters appears to suffer from this lack of clarity and from a rather controversial discussion of the author's hypothesis of the inheritance of hen feathering. The hypothesis includes identification of a factor having the mode of transmission assumed for the "W" chromosome (*viz*, from mother to daughter), with the secondary sexual secretion of the ovary. This material does not seem to be on a parity with the rest of the book.

Breeders of Barred Plymouth Rock fowls for exhibition will probably question his statement (p. 128) that "the show cock is usually heterozygous in the barring factor," while the homozygous cock is too light for exhibition. Evidence in support of this contention is lacking so far as the writer knows. The reason for using the "double mating" system by which Barred males and Barred females for show are produced from separate matings, is not to prevent the production of black females by the exhibition type of cock, but to increase the darkness of the male offspring by breeding from females which are darker than the standard shade, and in such matings standard type males are used successfully by both American and English breeders.

Biologists will welcome this book and need have no hesitation in recommending it to their poultrymen friends. With the growing interest of poultrymen in the principles of inheritance, it should have a wide sale, and could be put to good use as a text in a poultry course devoted to breeding.

It is uniform in format with the author's "Mendelism," and exhibits the same high quality of composition and press-work.

L. C. Dunn.

PRODUCTION OF DOUBLE CONE FLOWERS

David Griffiths
U. S. Department of Agriculture.

SINGLE AND DOUBLE CONE FLOWERS

Figure 9. Several stages of doubling are shown, from flowers with only a single row of ray-flowers around the base of the "cone" to those with ray-flowers nearly to its apex. It has been found impossible to reproduce the double flowered plants satisfactorily from seed, but greater success was attained with cuttings, the method used being described in the text.

IT HAS been fully ten years since the author found a completely double flowered form of *Ratibida columnifera* near Artesia Wells, Texas. This species as it grows in Texas is often a very different thing from what passes under the same name in the Northern Plains region. There it is usually low and spreading, but in Texas it may often be found 2½ to 3½ feet high, and when growing thickly, quite erect in habit.

The planting from which the stock in question was obtained was a very thick one, covering possibly one-twentieth of an acre, and most of the plants were fully three feet high. In it were all graduations of ray-coloration from pure yellow to deep maroon, the latter predominating. The double flowered forms seen by me were all of the maroon type and varied considerably in the amount of doubling, some plants showing it only a little,

while the flowers of one plant were fully double to the tip of the columnar spike. The character was confined to a small colony.

The plants were quite well in flower when the place was visited, but as no seed was ripe, arrangements were made with Mr. William Sinclair to send me seed later in the season. He sent a liberal quantity from the best plants which had completely double flowers. Unfortunately, this seed germinated very poorly.

Propagation of this seed was for a time carried on at two places. At Arlington Farm, Va., one lot of the seed was sown and about one hundred plants were potted off and grown to maturity. To our chagrin only one plant showed the double character pronouncedly enough to suit us.

At Chico, Calif., three successive generations of seedlings were grown in all, each from double plants in turn, with similar results. Never over four or five per cent of doubling was secured and no more than one or two plants that were considered fit to have. Finally at Chico the stock was allowed to volunteer for three or four years in a waste place, when there appeared several very good individuals which have recently been propagated. One of these is a comparatively large, vigorous plant with deep maroon colored rays extending to the apex of the flower spike. The other is a more dwarf spreading plant having yellow rays with the doubling extending nearly to the top of the spike.

It seemed useless, since so small a percentage of plants came true, to attempt to get the character fixed in the seed. Indeed, the double plants seed very poorly anyway, and no gain seemed to be made in growing successive generations from seed.

The plants grow large and bushy in California, and an attempt was consequently made to propagate by layering. Earth was banked around the plants in autumn, but no rooting took place. After considerable effort, Mr. Henry Klopfer has succeeded very satisfactorily in propagating from cuttings.

The cuttings are made of terminal growth late in the season, just before frost, when the wood is fairly well ripened. A heel is obtained when possible, but this is not imperative if the cut is made just below a leaf. These cuttings are set in sand in the bench with a little bottom heat. Plenty of water with perfect drainage is necessary. The cuttings are discouraging at first, for it is difficult to keep them from wilting, but after a day or two they begin to take up water and stiffen up. They are handled much like geranium cuttings.

After about six weeks in sand, callousing has taken place and root action started. In six or eight weeks the cuttings are ready to be transferred to pots. This should be done very soon after root action starts for the roots are very brittle and there are only one or two of them going directly downward. If potting is long delayed there is considerable loss owing to these characteristics. Commonly, about eighty per cent of the cuttings are successful, but this result probably can be improved upon with experience.

For best results it is necessary to produce young, vigorous plants each year. Stocks carried over or those stunted and starved are not satisfactory. In one instance plants with perfectly doubled flowers had the doubling reduced fully one-half the second year when carried over winter in a poorly tended and watered herbaceous border. On the other hand, plants of the same progeny maintained the character when allowed to run untended in fertile waste places even in competition with the common weedy annual grasses.

DELAYED GERMINATION AND THE ORIGIN OF FALSE WILD OATS

R. J. GARBER and K. S. QUISENBERRY*
West Virginia Agricultural Experiment Station

IN a recent issue of the JOURNAL OF HEREDITY one of the writers presented evidence concerning the origin of false wild oats, which indicates that they owe their origin to mutations rather than to natural crossing. Nilsson-Ehle[5]†, who was first to postulate mutations as the cause of false wild oats, has published[6] more evidence in favor of his theory.

Atwood[1] pointed out that delayed germination occurs in *Avena fatua*. He maintained that the restriction of oxygen by the seed coats was a limiting factor in germination and found that searing the seed coats with a hot needle materially increased the percentage of germination. Inasmuch as delayed germination exists in *A. fatua* one would naturally expect to find it also in false wild oats, provided false wild oats owe their origin to natural crossing between *A. fatua* and *A. sativa*. In the present paper are reported data obtained in an experiment made to determine the relative degree of delayed germination in false wild oats and in the second hybrid generation of certain crosses between *A. sativa* and *A. fatua*.

Methods

The plants used in this experiment were grown in the plant-breeding nursery on the Agronomy farm during the summer of 1922, from seed planted on April 3. At harvest time, which occurred between July 14 and July 21, the panicles of each plant were placed in a separate envelope and allowed to dry thoroughly in the sunshine before being stored in the laboratory. On September 15, kernels of all the plants reported on were placed in a standard germinating chamber. At the end of six days the germinated kernels were counted and removed. The remaining kernels were again placed in the chamber where they were left until September 28, when the final count was made. Before returning the kernels to the germinator some of them were treated either by searing the seed coats with a red-hot needle or cutting through the seed coats with a razor.

The seed-sample of each plant except in sixty instances consisted of twenty-five lower seeds. None of the upper seeds of an oat spikelet was used in the germination test. Because of scarcity of seed, each of twenty-one samples contained from ten to fourteen seeds inclusive and each of thirty-nine samples contained from fifteen to twenty-four seeds inclusive. In this test rag dolls were used as recommended by Holbert and Hoffer[4] for use in the germination of corn. From eleven to twenty-three samples were placed in each rag doll.

During the germination test the temperature was controlled by means of a water jacket and an ice chamber. Temperature readings were made morning, noon, and evening. From September 15 to September 21, when the first germination-count was made, the temperature was maintained between 17°C. and 19°C. From September 21 to Septemper 28 when the second and final germination-count was made, the temperature was maintained between 16.5°C. and 19.5°C. with the excep-

*Approved by the Director of the West Virginia Experiment Station.

†For Numbered References, see *Literature Cited,* at end of article.

tion of one night when a temperature of 15°C. was recorded.

Comparative Germination of Parents and Hybrids

The data for the germination test of Victory, *A. sativa,* Garton 748, *A. sativa orientalis*, and two varieties of *A. fatua* as well as the second generation seed of certain crosses, are shown in Table I. One of the fatua forms had a brown hairy lemma and the other had a yellow glabrous lemma.

In a few cases, seeds which showed no signs of germination at the expiration of six days and at that time were not treated by searing or cutting through the seed coats, showed weak germination at the end of thirteen days (Table II). The data in Table I are made up from the number of untreated seeds per plant which showed germination during the thirteen-day period.

Each of the fourteen Victory plants and five Garton 748 plants germinated 95 per cent or above. The eleven plants of the Yellow wild oat ranged from 0 to 55 per cent germination, whereas the eight plants of the Brown Hairy wild oat ranged from 0 to 25 per cent germination. Although the number of plants involved is somewhat small, the data indicate that the brown hairy wild oat shows a somewhat greater degree of delayed germination than the glabrous yellow wild oat. Data previously collected corroborate the above statement.

The individual plants of each second generation progeny tested show a wide range in percentage of germination. The only apparent exception is the cross Yellow Wild oat × Victory in which the range of germination is from 66 to 100 per cent. The reciprocal cross, however, shows a range in germination of 16 to 100 per cent. In the generations of all the other crosses, namely, Brown Hairy wild oat × Victory and the reciprocal, Garton 748 × Brown Hairy wild oat, and Garton 748 × Yellow wild oat, the range in germination is from 31 or below to 100 per cent. The data in Table I, comprising tests of seed-samples from 437 second generation plants, show that delayed germination is an inherited character and that in general the range in percentage of germination in the second generation is from the fatua parent to the sativa parent. The second generation individuals show a distinct piling up at the upper limit of the frequency distribution. In other words, delayed germination behaves as a recessive character in these fatua-sativa crosses.

The Test for Delayed Germination

In order to determine whether delayed germination was the main cause of seeds failing to grow during the first six-day period of the test, the ungerminated seeds of each of a larger number of plants were divided into two approximately equal lots. Before returning the seeds to the germinator one lot was treated either by cutting through or searing the seed coats and the other lot was untreated. After the treated and untreated seed had been in the germination chamber for an additional seven-day period, the number of seeds which had germinated was determined. The results are tabulated in Table II.

It will be noted from Table II that the germination of the Brown Hairy wild oat was less affected by treatment of the seed coats than was the germination of the Yellow wild oat or the second generation hybrid plants. Both the seared and cut seed of the second generation plants germinated approximately forty-five per cent while only one per cent of the untreated seed germinated. The data presented in Table II show that the seed treatment appreciably increased the percentage of germination.

When the germination test was completed it was found that the untreated seeds exhibiting delayed germination were still firm whereas seeds which failed to grow for other reasons were soft and partially decayed.

Relation Between Fatua Types and Delayed Germination in the Second Generation

In order to determine whether the fatua type was closely associated in inheritance with delayed germination, the second generation plants were classified on the basis of seed articulation, as fatua-like, intermediate, or sativa-like forms. The segregation in the second generation clearly indicated that a single factor difference controlled the type of seed articulation. Of all the crosses (including all plants whose seeds were not tested for germination), there were 110 fatua-like, 254 intermediate, and 124 sativa-like plants with regard to seed articulation (P. = 0.458). A correlation coefficient indicated linkage between type of seed articulation and percentage of germination for the second generation progeny of each cross was prepared. The tables were arranged so that a significant positive correlation coefficient indicated linkage between the fatua type of seed articulation and delayed germination. These correlation coefficients are presented in Table III.

All the coefficients except one in Table III are significant, and they show that in the second generation individuals delayed germination was associated to some extent with the fatua type of seed articulation. The magnitude of the coefficients, however, also shows that close linkage between these two characters did not exist. The lowest correlation ($r = +0.159 \pm 0.086$), was obtained in the progeny of the cross Yellow wild oat × Victory, and the highest correlation ($r = +0.538 \pm 0.048$) was obtained in the F_2 progeny of the cross, Garton 748 × Yellow wild oat.

High percentages of germination were frequently obtained from second generation plants with fatua seed characters. This is shown by the data in Table IV. The frequency distributions with respect to the percentage of germination of the fatua-like seeds for all the second generation progenies are shown. Only plants which produced seed with fatua-like articulations on both the primary and secondary seeds are considered in this group. There is a distinct accumulation of individuals at the upper limit of the distributions. Considering all the crosses, approximately one-third of the fatua-like plants produced seed which germinated from 95 to 100 per cent.

Linkage is indicated by the number of significant correlations obtained between the fatua-like second generation segregates and delayed germination. On the other hand a considerable number of these second generation segregates showed no delayed germination. These facts which are brought out in Tables III and IV indicate that in the fatua-sativa crosses reported in this paper delayed germination was linked with the fatua-like seed articulation, but the linkage was not close.

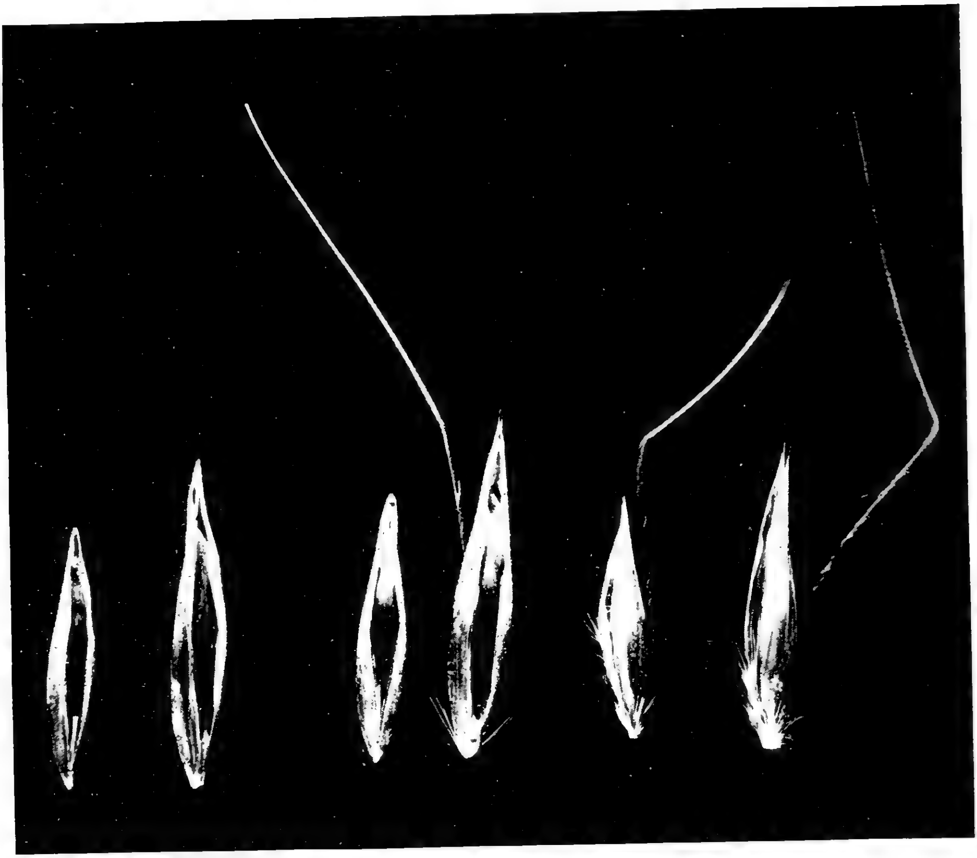
Germination of False Wild Oats

The homozygous and heterozygous false wild oats as well as the sativa forms reported below came from the same stock as those previously reported (Garber, 1922).[3] The progenies of heterozygous false wild oats showed segregation similar to that obtained previously. The segregation from heterozygous plants obtained in this investigation was as follows:

46 Victory, 74 heterozygous false Victory, 54 homozygous false Victory; 28 Garton 784, 84 heterozygous false Garton 784, 34 homozygous false Garton 784; 257 Aurora and heterozygous false Aurora, 76 homozygous false Aurora.

The phenotypes of Aurora and heterozygous false Aurora were so similar that no attempt was made to place them in a separate group. In general heterozygous false Aurora possessed a degree of awn development somewhat greater than that of pure Aurora but the difference was not marked.

The data in Table V show that there was no striking difference in seed germination among the various forms



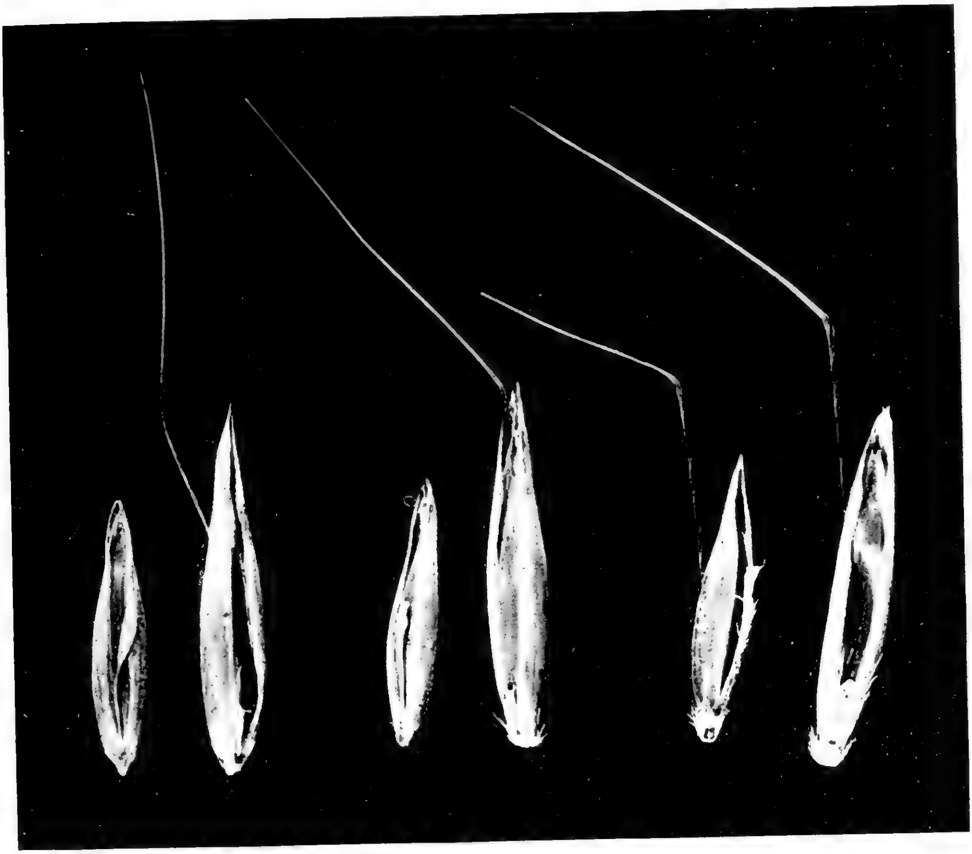
FALSE WILD OATS IN GARTON VARIETY

FIGURE 10. Left to right are shown normal, intermediate, and false wild Garton 784. The intermediate and false wild oats are characterized by awns, which are absent in the normal form. The false wild oats closely resemble wild oats (*Avena nuda*), and some authorities are of the opinion that false wild oats are due to natural crossing between wild and cultivated oats.

tested. In no case did a plant produce seed which germinated less than 70 per cent and only nine plants out of 184 produced seed that germinated less than 85 per cent. The sativa, the heterozygous false wild, and the homozygous false wild forms of the varieties Victory and Garton 784 are very similar with respect to seed germination. Homozygous false wild Aurora gave percentages of germination apparently somewhat higher than Aurora and heterozygous false wild Aurora.

The failure of some of the seed to germinate in the above forms was not owing to delayed germination. The seeds which showed no signs of germination at the end of six days were handled in exactly the same way as the ungerminated seeds of the parents and hybrids mentioned in the preceding section. In no case did a seared or cut seed of a sativa, a heterozygous false wild or a homozygous false wild plant germinate. Moreover every seed which failed to germinate during the first six days of the test, became soft and partly decayed by the time the test was completed (thirteen days.)

A year earlier a similar germination test was made of seed from homozygous false wild, heterozygous false



FALSE WILD OATS IN VICTORY VARIETY

FIGURE 11. Left to right are shown kernels of cultivated Victory oats, of intermediate (heterozygous) false Victory and of false wild Victory. Cultivated and false wild oats breed true, while the intermediate form segregates again, in the next generation, into normal, intermediate and false wild oats, in the ratio 1:2:1. The false wild oats are very similar to the true wild oats (*Avena fatua*) but the seed of the latter is delayed in germination by reason of having a heavy seed coat which is supposed to prevent oxygen from reaching the germinating embryo. This character is observed also in experimental crosses of wild oats with cultivated oats, but false wild oats does not show delayed germination. It therefore seems probable that false wild oats owes its origin to mutation rather than to natural crossing.

wild, and sativa forms of the varieties Victory and Garton 784. No difference in percentage of germination and no evidence of delayed germination were found.

The results mentioned above are similar to those obtained by Criddle[2] and by Nilsson-Ehle[6]. The evidence presented by these two investigators and the data reported here make it reasonable to conclude that false wild oats do not possess delayed germination similar to that found in *A. fatua*.

Conclusion

Seeds of wild oats possess delayed germination. Evidence is presented in this paper that in crosses between *A. sativa* and *A. fatua* delayed germination is an inherited recessive character and that it is somewhat loosely linked with the fatua-type of seed articulation. A germination test of seed produced by 437 second generation plants was made.

One would naturally expect to find delayed germination in some of the

TABLE I—*Frequency distributions showing percentage of germination of seed-samples from individual plants of the parents and second generation progenies of certain oat crosses.*

Name	PERCENTAGE OF SEEDS GERMINATED FROM INDIVIDUAL PLANTS																				Total Number of Plants
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	81-85	86-90	91-95	96-100	
Victory																				14	14
Garton 748																				5	5
Y. wild oat	2	1					1	2	2	1	2										11
B. H. wild oat	1	3	2	1	1																8
Y. wild oat × Victory														1	2	2	1	8	7	38	59
Reciprocal				1		1	1		2	1			3	3	1	3	1	13	6	42	78
B. H. wild oat × Victory			2		2	1						3	1	1	1	2	2	6	6	37	64
Reciprocal				2				1				3	2	2	4	5	2	2	7	32	62
Garton 748 × B. H. wild oat							2	3	1	1		2	4	2	3	4	8	5	10	28	73
Garton 748 × Y. wild oat	1	2					1	2	2	2		6	3	2	3	8	5	8	13	43	101

false wild oats, provided false wild oats owe their origin to natural crossing between fatua and sativa forms. Delayed germination was not found in seed from homozygous false wild, heterozygous false wild, or sativa plants. Here is direct evidence against the hypothesis that natural crossing between fatua and sativa oats adequately explains the origin of false wild forms. In view of the foregoing considerations, the origin of false wild oats is more reasonably explained by mutations than by natural crossing.

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Table II—*Effect of cutting through or searing the seed coats on delayed germination in oats.*

Name	NUMBER OF SEEDS								
	Seared	Germinated	Percentage	Cut	Germinated	Percentage	Untreated	Germinated	Percentage
B. H. wild oat	9	3	33.3	37	7	18.9	48	1	2.1
Y. wild oat	37	26	70.3	25	14	56.0	56	1	1.8
Seed of F_2 plants	212	96	45.3	215	101	47.0	305	3	1.0

Table III—*Correlation coefficients showing relation between type of seed articulation and percentage of germination in the second generation of certain oat crosses.*

Name	No. of Plants	r
Y. wild oat × Victory	59	+0.159 ± 0.086
Reciprocal	78	+0.422 ± 0.062
B. H. wild oat × Victory	64	+0.295 ± 0.077
Reciprocal	62	+0.477 ± 0.066
Garton 748 × B. H. wild oat	73	+0.485 ± 0.060
Garton 748 × Y. wild oat	101	+0.538 ± 0.48

Table IV—*Frequency distributions showing percentage of germination of seed-samples from fatua-like second generation individual plants of certain oat crosses.*

Name	PERCENTAGE OF SEEDS GERMINATED FROM INDIVIDUAL PLANTS 0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	81-85	86-90	91-95	96-100	Total Number of Plants
Y. wild oat × Victory															1		1	3	1	7	13
Reciprocal				1		1	1		1				2	2	1	1		5	1	7	23
B. H. wild oat × Victory			2		1							1			1		2	1		6	14
Reciprocal				2								3		1	1	2	2		1	2	14
Garton 748 × B. H. wild oat							1	3	1	1		1	2			1	1	1		3	15
Garton 748 × Y. wild oat	1	1					1	1				3	1	1	1			1		1	12
Grand Total	1	1	2	3	1	1	3	4	2	1		8	5	4	5	4	6	11	3	26	91

Table V—*Frequency distributions showing percentage of germination of seed from homozygous false and heterozygous false wild oats as well as the sativa forms.*

Name	PERCENTAGE OF SEEDS GERMINATED FROM INDIVIDUAL PLANTS 71-75	76-80	81-85	86-90	91-95	96-100	Total No. of Plants
Victory				1	5	18	24
Het. F. Victory				3	1	21	25
False Victory		1		2	4	18	25
Garton 784	1			3	2	12	18
Het. F. Garton 784				2	3	18	23
False Garton 784		1	1	1	3	16	22
Aurora and Het. F. Aurora		3	2	5	6	10	26
False Aurora				1	1	19	21

EUGENICS IN FRANCE

A Review

THE World War cost France about 3,000,000 citizens, counting the deficit in births as well as actual deaths. Indirect consequences such as the malnutrition of infants, and the spread of diseases in the civil population, will doubtless account for several hundred thousand more individuals lost to the nation, if not already, within the next decade or two.

It is natural enough, then, that eugenics should have an increased interest for the French. The movement has never been influential in France, for a number or more or less obscure reasons. The fact that French scientists had little to do with the origin of this science may in some measure explain the lack of interest which they have shown in eugenics; then, too, many French biologists have Lamarckian leanings which do not predispose toward a conventional point of view. Again, the respect for personal liberty and freedom of opinion and action in France is incompatible with some phases of eugenics, at least as popularly represented.

For these and other reasons, eugenics as such has not played an important part in the republic. There has been for some years an active propaganda for more births, since for a long time the annual births in France have exceeded the annual deaths only slightly, if at all. But this propaganda has been quantitative, and has paid little attention to that point of quality which is the crucial one in all eugenic measures. The nation was one of the last to organize a society of eugenics, and this organization has never been numerically strong.

A series of addresses delivered by members of this *Société Francaise d'Eugènique* has now been published[1] in book form—the first book, so far as I can recall, published in France in the direct interest of eugenics. It gives an extensive and trustworthy picture of the state of that science among the French.

Of the nine papers included, seven will be new to most students. Of the remaining two, one is a reprint of the address delivered by L. Cuenot at the International Congress of Eugenics in New York a couple of years ago; the other is a translation of an address on practical eugenics by Leonard Darwin. The other seven vary in character; several are thorough-going and admirable statements; others are timid and hesitant approaches to a point of view that is, to most Americans, commonplace enough. Thus it is something of a surprise to hear the late Edmond Perrier, former president of the society, confess that "in a civilized country, no one can dream of suppressing individuals burdened by hereditary defects, nor of preventing them from reproduction;" while F. Houssay supposes that the program of the movement must be a "war on defects, not on defectives." No one who has grasped the import of modern developments in genetics can fail to perceive that the only way to eliminate many defects is precisely to eliminate the defectives; and that the way to eliminate the defectives is precisely to prevent their reproduction. If many French eugenists hold such viewpoints as those just quoted, the prospects for an effective campaign are slight.

It is true enough that to favor

[1] Eugenique et Selection, par E. Apert, L. Cuenot, le Major Darwin, F. Houssay, L. March, G. Papillaut, Ed. Perrier, Ch. Richet, G. Schreiber. Pp. 248, prix f. 15 net. Bibliotheque Generale des Sciences Sociales, Librairie Felix Alcan, Paris (108, Boul. St. Germain), 1922.

the reproduction of the germinally superior is more important than to prevent the reproduction of the inferior (although each effort has its proper place in eugenics); and such measures as have been officially adopted in France, by tending to increase the birth rate, will have a valuable eugenic effect in so far as they are selective. But a review of them will show that they leave much to be desired.

1. The law of July 13, 1913, grants a monthly bonus to each family having more than three children under thirteen years of age; the bonus applying to each child in excess of three, and continuing until the child reaches his thirteenth birthday. The state, department, and commune join in the financial provisions for this bonus, the amount of which is not stated.

2. The law of June 28, 1918, promises state assistance to departments which give bonuses for children; the amount contributed by the state varying directly with the number of families having more than four children, and inversely with the wealth of the department. The law has in view not only an allotment for the maintenance of children, but a sort of insurance fund which will provide either a capital for the children when they mature, or else an old age pension for their parents. But the terms of this law, according to L. March, are too onerous to permit the participation of the poorer departments.

3. More than seventy large industrial organizations have established associations of their employees, somewhat similar to the familiar mutual benefit association. The employees contribute regularly small amounts, which they can draw out as their families increase in size; and the funds are increased by contribution of the employer, proportional to the amount of his total payroll. The last provision assures that the employer will have no interest in giving a job to a single man in preference to a family man.

4. Civil service employees, and also those of many private enterprises, receive regular increases in pay proportionate to increases in their families.

5. Tax measures provide an increase of twenty-five per cent in the income tax of bachelors, and exemptions for the fathers of families.

6. Members of large families are granted special rates on the railways.

7. The law of July 31, 1920, makes severe provisions against abortion and the sale of contraceptives.

Without stopping to analyze any of these measures in detail, one can see at a glance that such real eugenic effect as they may have is for the most part indirect and, so to speak, accidental. On the whole, they obviously represent an attempt to secure quantity of population, without definite provision for quality.

Numerous other measures are proposed by the writers in this volume. G. Schreiber, secretary of the French eugenics society, urges the importance of a compulsory medical examination prior to marriage,—without any prohibitory or other restrictive measures attached to it. Dr. Apert pleads for an intensification of the campaign against infant mortality, tuberculosis, syphilis, and alcoholism,—although all four of these afflictions are, strictly speaking, eugenic to some degree, and their reduction should therefore be accompanied by some real eugenic measures to counterbalance. F. Houssay, in a most interesting communication, argues that much of the sterility of civilized peoples is due to auto-intoxication, following particularly on the excessive use of meat, alcohol, and condiments, and cites in detail an experiment of his own in which fowls fed on an exclusive diet of fresh meat showed progressive sterility until in the sixth generation the line became extinct. Indeed, every one of the papers in this volume is distinctly worth study, not only because of the information presented, but because they show eugenics in what, to Americans, is for the most part a novel aspect. —PAUL POPENOE.

THE LIMITATIONS AND PROMISES OF EUGENICS

ROBERT K. NABOURS[1]

Kansas State Agricultural College

IN A letter to Wallace, as long ago as 1857, Darwin said: "You ask whether I shall discuss man. I think I shall avoid the subject as surrounded with prejudices; though I fully admit it is the highest and most interesting matter for the naturalist." We have made enormous progress along many lines in the sixty-five years since Darwin made this modest but significant statement, but as students, are we yet able to place ourselves outside the herd and approach the subject of the evolution of human beings and human society in the spirit, and with the method, of science? As Karl Pearson submits the question, "Can we place ourselves outside the community of which we form a part, and study the effects upon it of environment, of occupation, of nourishment and of breeding in the same judicial manner as the owner of a herd of shorthorns approaches the like problem?" This question cannot be answered lightly, "yes" or "no," according to the taste or sentiment or disposition of the individual or the time.

Complicating any effort at an answer, Pearson suggests that, "We are not in the position of the owners, but we are members of the herd ourselves—with all the feelings of our class, the prejudices of our education, or want of education, the strong emotions of our sex and the complex passions of our race." As yet perhaps only the men of medicine and of the judiciary and a rare psychologist, are able to approach the ideal of placing themselves apart, and repressing sternly the personal for the furtherance and effectiveness of their respective professions. I mean that they can do this and still be interested in, and even love their fellow men, in contradistinction to that cold-blooded, nerveless placing of one's self outside the crowd for base purposes, a feat which can often be accomplished by the lowest and meanest. Outside the noble professions mentioned, and even some of their members are at times under suspicion, it is doubtful if the accomplishment of placing one's self apart and outside the herd is more than rarely effectively attained. If, however, it can be agreed that there are even a few who can study human beings and human affairs as cases and largely without the deep prejudices already enumerated, then we have made a promising start and a practical ideal beckons us on.

The Problem

An impediment in the path of progress is the question of the goal toward which to drive. Fortunately, so far as can be seen, this need not cause delay in the eugenics movement in the near future. Nevertheless, it will necessarily have to be considered eventually. Is the ideal a race with perfect form and health, the population limited so that there will be abundance for all, each individual observing the Golden Rule; no strife, no wars, all living in harmony and agreement, each for all and all for each; and everybody living to extreme old age? What a monotonous, uninteresting situation! Who would want to live there and then?

Dr. Schiller observes that:

[1] Presidential address before the Kansas Academy of Science, February 16, 1923.

Eugenics and civilization are actually in the same boat, and that the theoretic difficulties of the former are identical with those of the latter. Both are rooted in the notion of the good, but neither of them knows what the good is, and both are vitally affected by the doubts and disputes that beset the good. If we cannot tell what the good is, we can neither know how to better the human race, nor decide whether civilization is or is not a good thing. And in either case, if we disagree about the good, we shall get divergent aims, quarrel about it, and shall probably have to fight it out; with the result, very likely, that both sides will miss the good they aimed at.

To know what is the good, especially in such a large matter as civilization, is a far more complex matter than it is ordinarily considered to be. In the oasis and city Bokhara the number of inhabitants is strictly limited by the amount of water brought down from the mountains by the Zarafshan River, while from the country there is a very small emigration of the surplus population. Social and religious customs demand that every woman bear all the children possible, and death is a conspicuous feature, especially among the young. The enormous population, as in all Oriental countries, lives exceedingly scantily. With eyes opened wide with wonder I was being shown around by a Russian gentleman and was making photographs of the people and remarks about their slow ways, violations of the rules of sanitation and health, their complacency, improvidence, leaving everything to Allah, and so forth. Then my philosophic guide said:

You see these people doing all these things so differently from the strenuous ways of your U. S. A., and you say to them: 'Bokharans, why don't you wake up and take to the strenuous ways of my country? Why put off till tomorrow that which can be done today; you fools!' I, a Russian from Moscow, say to them (this was a few days before the beginning of the late war), 'Why don't you wake up and do as we Russians do,' and I say 'you fools!' Then these people, as they sit around sipping their tea, philosophising, awaiting death and Allah, look at us from their quiet eyes, as we 'rubber neck' among them, and they say, 'You westerners, you nervous, strenuous people, quiet your nerves. Why do today that which can be put off till tomorrow? You fools!' Now, professor, I ask you, who are the fools?

Another angle of the same problem is given by Popenoe and Johnson:

At the First Race Betterment Congress at Battle Creek, one afternoon the discussion turned to the children of the slums, and their conditions were pictured in dark colors. A number of eugenists remarked that such children were in many cases handicapped by a poor heredity. Then the revered Jacob Riis strode upon the platform, filled with indignation, and said:

"We have heard friends here talk about heredity. The word has rung in my ears until I am sick of it. Heredity! Heredity! there is just one heredity in all the world that is ours—we are the children of God, and there is nothing in the whole big world that we cannot do in His service with it."

It is probably not beyond the truth to say that in this statement Jacob Riis voiced the opinion of a majority of the social workers of this country, and likewise a majority of the people who are faithfully and with much self-sacrifice supporting charities, uplift movements, reform legislation, and philanthropic attempts at social betterment in many directions. They suppose that they are at the same time making the race better by making the conditions better in which people live.[2]

This introduces the problem, and it seems to me, states it very succinctly. It is the problem of the interactions of the factors of nature and of nurture, or the heritage and the environment. When this used to be a subject for discussion in the good old country school debates, we usually treated it as though one or the other, nature, or nurture, comprised the whole economy of an individual. In such a debate we succeeded about as well as when we took sides on that other ancient question entitled "What would happen if an irresistible force should meet an immovable body?" The answer usually was, "the inevitable." Like the old codger who, after looking a giraffe over, concluded: "Well, there just ain't no such animal," so we might begin with the premise that there is no such

[2] Popenoe and Johnson, *Applied Eugenics.* The MacMillan Co., 1918.

thing as the heritage without environment or the environment without the heritage—no possibility of the consideration of nature without nurture, or, nurture without nature. The factors of each are inextricably involved with the other. It is a big step forward that all can agree on this point, as I believe we do, but even so, we have only arrived at the stage where discriminate consideration is possible.

Are Acquired Characters Inherited?

We are impelled thus to inquire whether changes in the environment, or nurture, will change the nature that has been inherited in such manner that the changes that may be accomplished can be transmitted to the offspring.

Among the biologists I am sure it is well known that this question of the inheritance of acquired characters, or the induced mutability of the germinal substance, is to the front and is probably as lively a subject of discussion today as it ever has been in the past. Let us examine this question as well as may be possible in the time at our disposal. No detailed presentation of the data is intended now; only references may be made to some of the more prominent experiments.

In the famous experiments of Brown-Sequard, epilepsy and other characters were induced in guinea pigs by severing the spinal cord, or sciatic nerves. These acquired characters apparently were inherited by the offspring, but I believe geneticists now recognize that this claim has been refuted several times. I know no investigator who now attributes, except historically, the slightest importance to them.

Tower's experiments with potato beetles were popularly widely hailed as giving convincing proof of the possibility of the permanent modification of the substance bearing the factors of the heritage by the impingment of the environment, but critical examination of his data leaves much to be desired. I believe it is the consensus of judgment, and without disparagement of his brilliant achievements, that an open mind should be maintained concerning the interpretations which ought to be given to his results.

Kammerer, an Austrian biologist, has published accounts of experiments on the inheritance of induced characters in certain amphibia. In the one case a frog, *Alytes obstetricans,* is found in nature to have departed from the usual habits of frogs to the extent that the eggs are laid and fertilized while the pair are on the land. Afterward, the male, on whose hind legs the fertilized eggs are retained, seeks water where hatching takes place and a very short tadpole stage is passed. Furthermore, in nature, the male of *Alytes* does not have pads, or swellings, on his thumbs which are common on the thumbs of other frogs that mate in the water where the pads are thought to be helpful in holding to the bodies of the females. Briefly stated, Kammerer maintains that he has, by forcing these frogs to mate in the water through a few generations, caused them and their offspring to retain the habit of mating in the water, even when restored to conditions favorable for mating on land, and that the tadpole stage has been greatly lengthened. But of probably greater significance, the male has developed the pads, or swellings, on the thumbs which enable him to hold the females better while mating in the water. All this is thought to be a restoration, and causing to be inherited, of characters which these frogs are supposed to have lost, presumably by use and disuse, in the same way as they have now been restored.

Kammerer claims also that he has induced heritable color changes in salamanders by maintaining them on differently colored soils.

Professor Bateson has assailed Kammerer's work on a number of points which are too extensive to be

recounted here. Suffice it to say that Bateson leaves one in a very critical state of mind regarding Kammerer's claims. On the other hand, McBride, the English zoologist, gives credence to Kammerer's published results, and claims that Bateson is too severe with him. Nevertheless, it is the privilege, and even the duty, of scientists to maintain an attitude of skepticism on crucial results. Pending a better understanding of all the features of Kammerer's experiments, and independent repetition of them, an open mind is all that may be rightfully demanded of anyone.

Another experiment now in progress in the United States bears on this problem. Guyer and Smith, of the University of Wisconsin, injected emulsified lenses of the eyes of rabbits into hens. Afterward they took the blood serum of the hens, presumably containing rabbit lens anti-bodies and injected it into the blood stream of pregnant rabbits. When the young of these rabbits were born a few of them were found to have various degrees of defective lenses, the lenses having been almost eliminated in some cases. These lens defects have been inherited through several generations, through the male as well as the female parent. It appears that the anti-lens substance acted not only upon the lenses of the developing rabbit fetuses, but also on the germ plasm; or it acted on the lenses which in turn produced something that acted on the germ plasm.

This experiment, conducted by biologists of such integrity and training has aroused great interest. While as in almost all things, there is room for criticism of some phases of the experiments, nevertheless great hope of real progress in this field has sprung up.

That nurture may often have tremendous influence on the nature that has been inherited is made manifest in many ways, as illustrated by the effects of nutrition, poisons, heat and light, abrasions, friction, exercise, and so forth. Most people assume without question that such effects are inherited. Thousands of volumes could be crowded with the anecdotal evidence supposed to exemplify such inheritance. There are also the efforts of the scientists, many more than those that I have recounted. Nevertheless none of these accounts, nor the experiments, leave us quite certain that any such effects recur from generation to generation without the recurrence of the affecting agency. What an anomaly that with the abundant opportunities for observation not one single alleged case of the inheritance of acquired characters, or the induced mutation of the bearers of the heritage, can as yet be accepted with complete conviction.

That is, if the materials and conditions recorded as used in the experiment were duplicated we have no assurance that similar results would be obtained by independent workers. Until such unquestioned duplication of results are obtained by others using the same, or similar methods, the brilliant experiments of Brown-Sequard, Tower, Kammerer, and Guyer and Smith can hardly be accorded a position of greater consequence than that of harbingers of promise, and stimulates to further effort.

An effort has been made to present the most striking results tending to show that the effects of the environment may be transmitted. The tentative conclusion reached, at least by the speaker, is that entirely satisfactory proof has not been forthcoming.

The Immutability of the Germ Plasm

Now let us examine some of the evidence which indicates how difficult it is to influence the germ plasm by impingement with the environment. One line includes ovarian transplantation, another, identical twinning, and the third, Mendelian heredity.

The physiologist, Heape, took the fertilized egg of the long-haired, white Angora rabbit before its implantation

TWIN LAMBS, BUT DIFFERENT IN COLOR

FIGURE 12. The sire of these lambs was a black hybrid produced by crossing a Karakul ram with a Cotswold ewe, similar to the mother of the lambs. This illustrates Mendelian segregation of characters, as the black and white color-factors have not blended, but have remained distinct. If mated with white animals all the offspring of the white lamb would be white, while half of the black lamb's offspring would be black and the other half white.

and placed it in the uterus of the short-haired, gray Belgian hare. The Belgian hare than gave birth to a typical long-haired, white Angora rabbit, without the slightest resemblance of the Belgian breed. The Belgian hare to whose uterus the egg had been transplanted had been only the foster mother, having influenced the fetus, even in these most intimate of relations, not at all.

Castle and Phillips performed, in this connection, a very significant experiment using guinea pigs. It may best be described in Castle's words:

> A female albino guinea pig just attaining sexual maturity was by an operation deprived of its ovaries, and instead of the removed ovaries there was introduced into her body the ovaries of a young black female guinea pig, not yet sexually mature, aged about three weeks. The grafted animal was now mated with a male albino guinea pig. From numerous experiments with albino guinea pigs it may be stated emphatically that normal Albinos mated together, without exception, produce only albino young, and the presumption is strong, therefore, that had this female not been operated on she would have done the same. She produced, however, by the albino male three litters of young, which together consisted of six individuals, all black. The first litter of young was produced about six months after the operation, the last about one year. The transplanted ovarian tissue must have remained in its new environment therefore from four to ten months before the eggs attained full growth and were discharged; ample time, it would seem, for the influence of a foreign body upon the inheritance to show itself were such influence possible.

Another similar experiment has been performed in poultry by Daven-

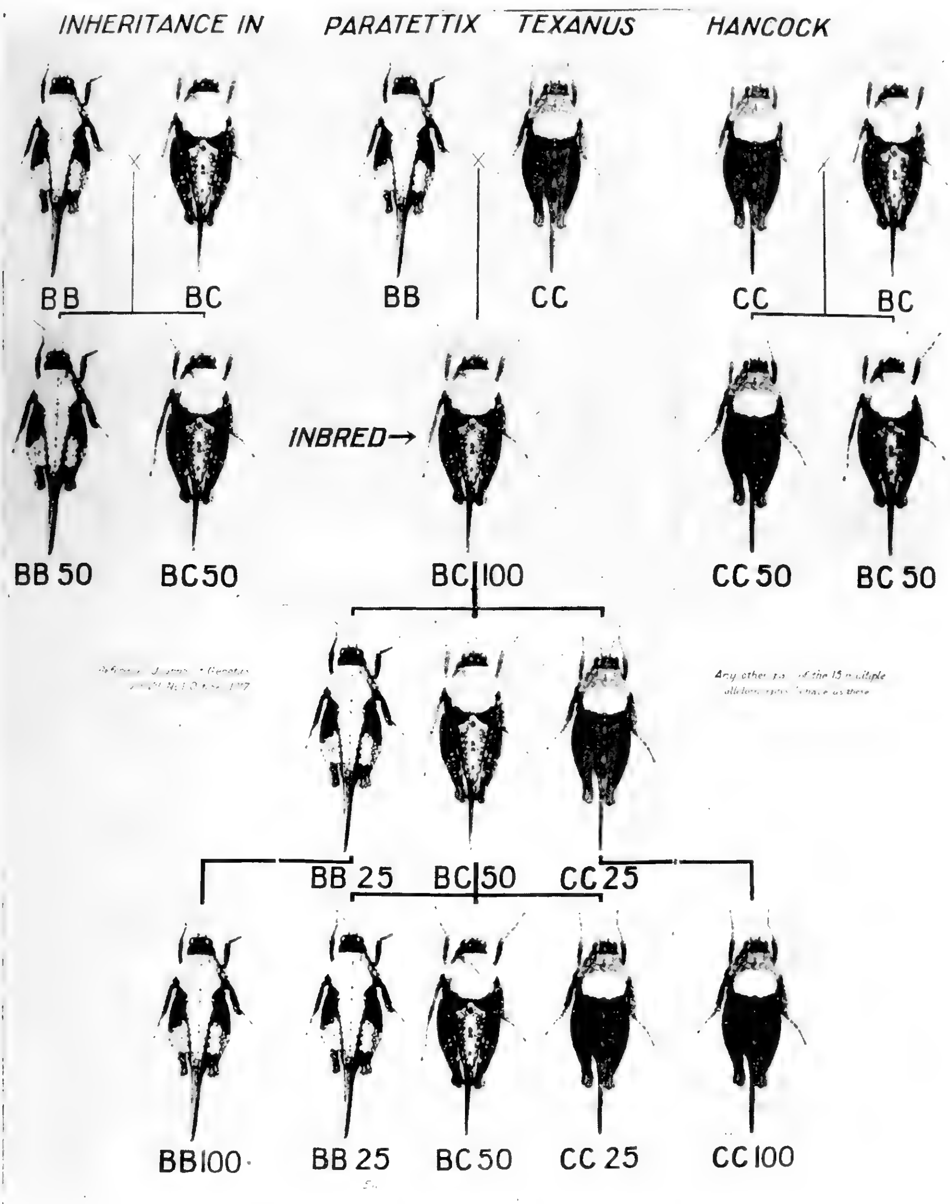
port and with results identical with those obtained by Castle, and Heape, with guinea pigs and rabbits, respectively. It is hardly necessary to suggest that these results offer striking evidence of the preponderant role played by the germ plasm in heredity. It appears that the germinal material is peculiarly insulated from the body as far as any influence on its capacity as the carrier of the heritage goes.

The causes of the appearance of the two kinds of twins in man appear now to be quite clearly understood, due to the brilliant work of Galton, Newman, and Patterson. The one class of twins may consist of a boy and a girl, or both may be of the same sex. In either case, the one usually differs from the other in respect to a few, or even a great many, characteristics, just as any brother may differ from brother, sister from sister, or as sisters from brothers. In this, the more common kind of twinning, it appears to have been quite definitely ascertained that each individual is derived from a separate egg, and as far as heredity is concerned, the difference between the two may be the same as if they were born years apart. Such twins as these I am sure you have often seen, this one tall and thin the other short and fat, the one with black, the other with blue eyes; the one with curly, the other with straight hair; the one with a certain disposition, the other entirely different, and so on, as might be the case among children born of the same parents at the usual intervals.

The other kind are designated as identical twins. They are invariably of the same sex, and are alike in practically all respects at birth. It appears well established that they are both derived from the same fertilized egg cell.

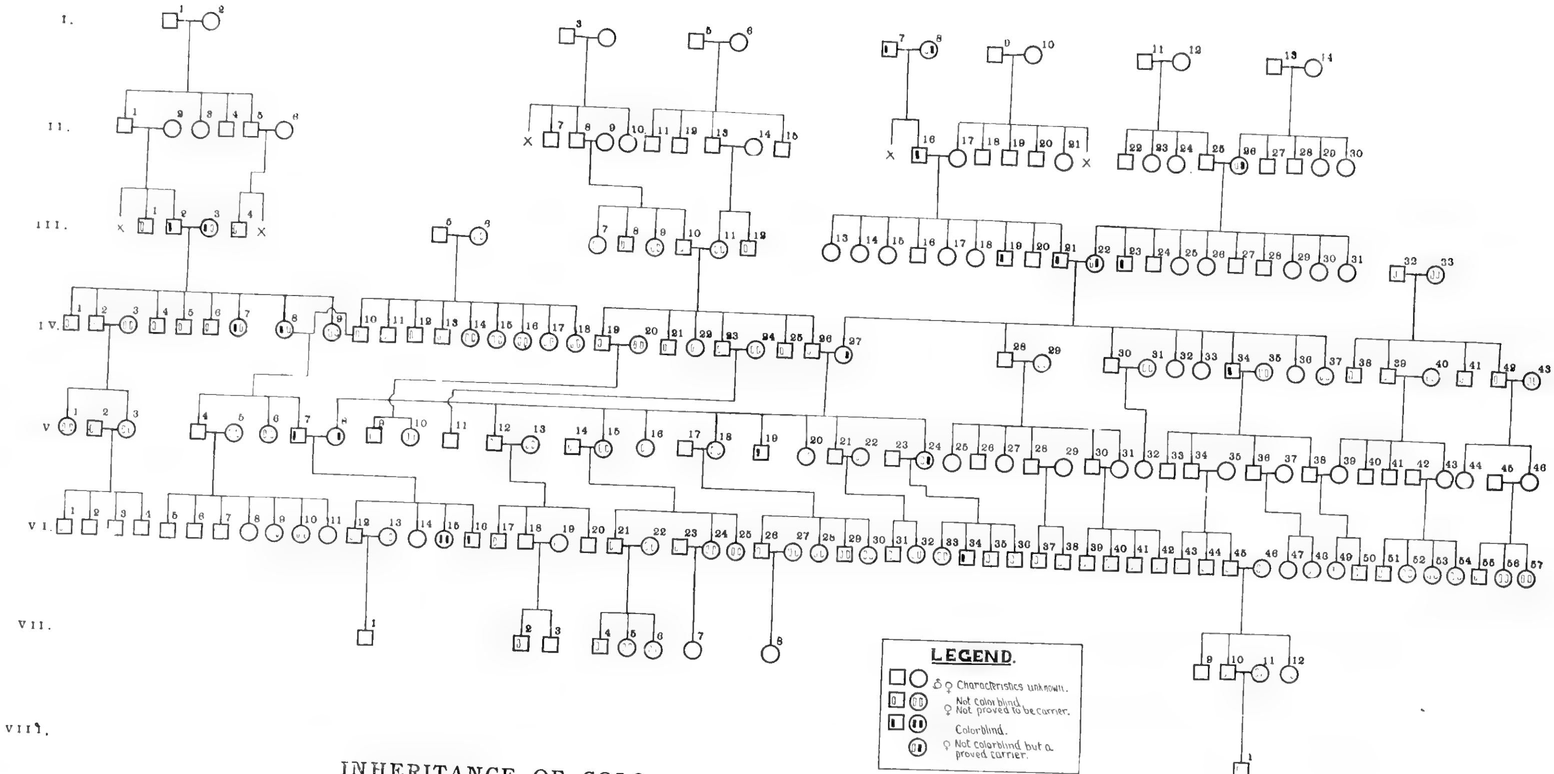
It was Sir Francis Galton, the father of eugenics, who made the first important study of identical twins, having collected accounts of eighty pairs. The records of thirty-five pairs were given with remarkably complete details. These records showed that such twins presented extraordinary resemblances in childhood, and these likenesses persisted to a remarkable degree throughout life. You are undoubtedly familiar with one or more pairs of such identical twins. They invariably have the same bodily characteristics, except in case of accident before, at, or after birth, and their mental and other traits appear also to be identical. If they suffer no deforming accidents, and are dressed in all respects alike, it is quite impossible to distinguish between them. It has been my fortune to become intimately acquainted with two pairs of such identical twins. In the one case two small elementary school girls were exactly alike, and dressed alike, and although I taught them every school day for several months, I never came to the point where it was possible to know them apart. Their resemblances extended to mental traits also. Two brothers were my college mates for four years, living in the same house, and part of the time in adjoining rooms. Although they were my intimate associates in many affairs, on account of their similarity, extending even to minute matters of habit, and as they took pride in dressing alike in all respects, I was never sure of their individual identity. One of them had spent some years with missionary parents in China, while the other had been with relatives in this country, and a good portion of their lives had been lived in different environments including food and climate.

Galton narrates numerous amusing as well as serious anecdotes concerning the eighty pairs of identical twins whose histories he studied. Most of these anecdotes related to the difficulties of parents, relatives and tutors and even of the twins themselves in distinguishing between the members of such pairs. In one case doubt remained whether the children were not changed in their bath, and the pre-



INHERITANCE IN THE GROUSE LOCUST

FIGURE 13. This photographic chart shows the inheritance of two allelomorphic characters in the Grouse Locust (*Paratettix texanus Hancock*). When the pure type BB is crossed with another pure type CC, the resulting locusts are all of the genetic constitution BC, with regard to the two characters in question. When these hybrids (the first hybrid generation, or F_1 of the geneticists) are inbred, three types are produced: pure BB's (25 per cent), BC's, similar to those in the preceding generation (50 per cent), and pure CC's (25 per cent). The two pure types breed true, while the hybrids (BC), when inbred give the same result as in the first generation. At the upper right and upper left corners are shown the results of mating a pure type with an intermediate. This chart could be used to illustrate the behavior of other characters in the Grouse Locust, and of many characters in plants and animals.



INHERITANCE OF COLORBLINDNESS—A SEX-LINKED CHARACTER

FIGURE 14. The factor for colorblindness is carried in the so-called X-chromosome, one of the two sex chromosomes. The small rectangles within the squares and circles represent the X-chromosomes, of which there are two in the cells of females and one in the cells of males. Colorblindness is recessive, and does not appear in the presence of its normal allelomorph. Therefore colorblind women are much rarer than colorblind men, as they only appear when a colorblind man marries a woman who carries the defect latently. Such a case occurred in the sixth generation shown in the chart, where the woman VI-15 is colorblind. The condition of her children with respect to this defect can be predicted with accuracy. None of her sons will ever distinguish red, green, or blue. They can never be railroad men nor belong to the signal corps. One-half of her daughters' sons will also be colorblind, although the daughters themselves will not be so afflicted—assuming, of course, that the colorblind woman marries a man with normal color vision. Chart prepared by Nellie Payne and the author.

sumed A was not really B and vice versa. Other incidents range from nine cases of a twin seeing his or her reflection in a looking-glass and addressing it in the belief that it was the other twin in person, to the difficulty which children found in distinguishing, in one case, a mother from her identical twin sister, and another case, a father from his identical twin brother.

In Galton's own words:

> Among my thirty-five detailed cases of close similarity, there are no less than seven in which both twins suffered from some special ailment or had some exceptional peculiarity. Both twins are apt to sicken at the same time in no less than nine out of the thirty-five cases. Either their illnesses, to which I refer, were non-contagious, or, if contagious, the twins caught them simultaneously; they did not catch them the one from the other.

Galton found that in many cases resemblances in body and mind continued unaltered up to old age, notwithstanding greatly altered conditions of life. He says further:

> The twins (not identical) who closely resembled each other in childhood and early youth, and were reared under not very dissimilar conditions, either grow unlike through the development of natural (that is, inherited) characteristics which had lain dormant at first, or else (if identical twins) they continue their lives keeping time like two watches, hardly to be thrown out of accord, except by some physical jar."

In the same careful, cautious manner, Galton examined the records of a large number of ordinary twins who were unlike from the start. It is a long catalog of increasing dissimilarities in many respects of body, mind, disposition, ability, immunities and susceptibilities, although the environment and training had been very much the same throughout.

He then concludes:

> There is no escape from the conclusion that nature prevails enormously over nurture, when the differences of nurture do not exceed what is commonly to be found among persons of the same rank in society and in the same country.

So far practically all the discussion has centered on the question as to whether or not induced, or acquired, characteristics may be transmitted in the heritage. An effort has been made to present an unbiased summary of the evidence both for and against the idea. The only fair conclusion which seems possible is that the question may not at the present time be answered positively with yes or no. As indicated already, however, the alleged positive evidence is not satisfactory, while the facts against the idea are certainly quite strong.

Mendelian Heredity

The sentiment of Jacob Riis, and the word sentiment is here used advisedly, that by making the conditions better in which people live we are at the same time making the race better, certainly strikes the popular chord. If there were no alternative to this view that the heritage must be modified by the environment before race improvement is possible, the outlook, from the point of view maintained in this paper, would be gloomy indeed. Fortunately there are alternatives the features of which have undoubtedly been involved in race improvement for ages, perhaps without racial consciousness, or at least with only racial subconsciousness. These methods are still available, but whether for conscious application, or not, it would probably be imprudent at the present time to make predictions. One of these alternatives that I would like to place before you for examination consists of the principles and materials of Mendelian Heredity. Naturally only the barest outlines of so inclusive a subject may be presented, and I shall use, for the most part, some materials with which I am most familiar.

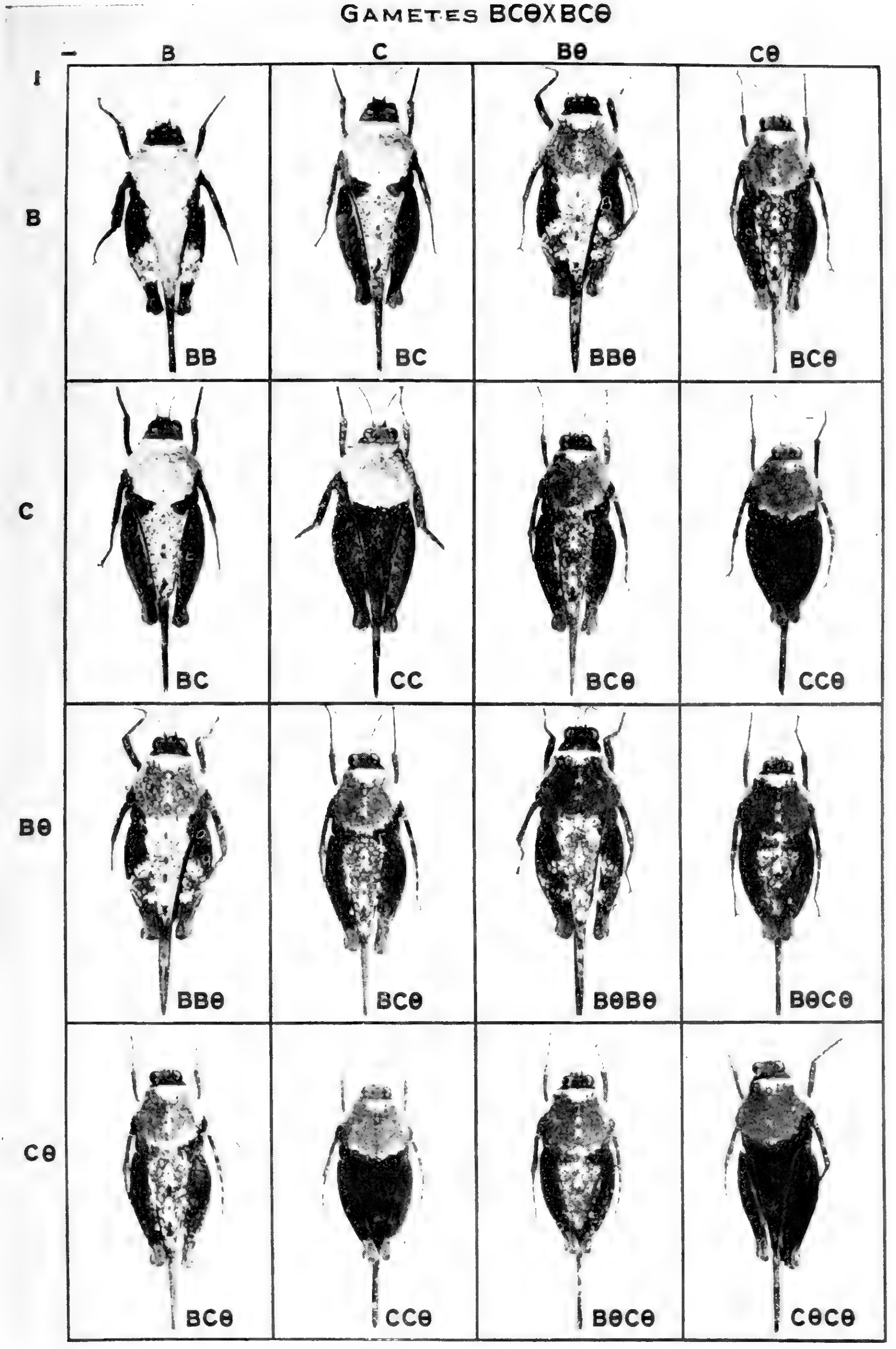
A breeding investigation using organisms such as the grouse locusts is justified and supported on the ground that this, supplemented by records of the breeding results in cattle, sheep, and pigs of other, including commer-

cial, projects, and such records of human breeding as are available, would probably be the most direct method of approaching an understanding of the laws governing the inheritance of characters in domesticated animals and man. Thousands of grouse locusts of strikingly contrasting characters and for ten or twelve succeeding generations may be bred with the facilities, expense and time required in breeding one, or two, of the higher domesticated mammals. Just as the bulk of the facts of surgery and medicine has been gained largely through experimentation on lower animals, so it appears that an approach to an understanding of the laws of inheritance as applied to domesticated animals and man may be made, with proper supplementation, largely through the utilization in experimentation of such rapidly breeding and comparatively simple forms as fruit flies, grouse locusts and lower mammals.

Th breeding pens and cages of the geneticists are instruments analogous to the test tubes and mortars of the chemist. This is not overdrawn, for in the breeding of fruit flies millions of reactions of the factors of heredity have been recorded. In one experiment with grasshoppers we have checked and recorded more than 350,000 reactions among contrasting characters. Many other groups of animals and plants have been used in the same way. It is a fact that thousands of the factors which manifest themselves in the characters of animals and plants are every day being manipulated with the same precision and method as are applicable to the operations of the chemical elements. Even the same difficulties of errors resulting from contaminations, failure in the identification of end results, etc., have to be met. The precision with which genetic factors react towards each other has called for the establishment of a special branch or sub-branch of mathematics with which to deal with the subject; so that now when one contemplates entering the field of genetics he finds a knowledge of certain lines of mathematics a prerequisite.

There are about 140 characteristics of man known to be inherited. It has been ascertained that a large proportion of these are inherited according to Mendelian expectation, and none have been proved to be inherited otherwise. Color blindness, a chart for which I have shown (see Figure 14), is one of the conspicuous examples of those which have been thoroughly worked out. Skin color; the hair, whether straight, curly, kinkey, golden, red or black; tallness; dwarfness; thinness; fatness; bodily malformation; susceptibilities; immunities; inebrity; sobriety; sex immorality; criminality; inbecility; intellectuality; ambition; vigor; longevity; altruism and religious fervor are a few of the constantly increasing number of such heritable characters that are coming into recognition.

We have time to consider only one characteristic of man, besides the case of color-blindness already illustrated. I shall take the case of skin color of the negro studied especially by the Davenports. After extensive studies they concluded that there are two factors for black pigmentation in the full-blooded negro of the West coast of Africa. Briefly this means that the mulatto first generation offspring from pure black crossed with pure whites, when inbred, should produce one pure white and one pure black in every sixteen of the second generation offspring. (See Figure 15.) Now, this refers to color only. According to the laws of the shuffling of factors, the pure white individual in color may have more of the other negroid characteristics, such as flat nose, thick lips, curly hair, mental traits, than the pure black individual of the same parentage and *vice versa.* To secure a pure black, with all other negroid characters, or a pure white, with all other Caucasian traits from mulattos would be a very rare occurrence in-



INHERITANCE OF THREE FACTORS IN THE GROUSE LOCUST

FIGURE 15. The inheritance of color characters in the Grouse Locust is analogous to crosses between whites and negroes. White skin color in man is believed to be due to a single factor similar to that of the white Grouse Locust, BB (upper left-hand corner of chart). Black pigmentation of the negro is controlled by two factors, as is the case with the black Grouse Locust (lower right-hand corner). In crossing pure white individuals with pure black, hybrids or "mulattoes" are produced that have the genetic formula **BCθ** (the four figures running diagonally across from upper right to lower left.) When these "mulattoes" are inbred, the result is that represented by the sixteen figures in this chart. There are nine kinds of offspring, and all can be recognized. Of the sixteen, one will be pure white and one pure black, as far as color factors are concerned, but other factors are independently distributed.

deed. This accounts for the appearance, on South State Street, Chicago, for instance, of an individual as black as the ace of spades, but with a Caucasian face, straight (even red) hair, with the color, and possibly the mental makeup of a scion of the old South. On the other hand, one may see a lily white individual with negroid face, head, and hair, and many stages between these.

A criticism that comes to us frequently is to the effect that genetics, and especially eugenics, deals, for the most part with malformations and disorders of various sorts—"albinos, brachydactyls, cretins, dwarfs, freaks, giants, hermaphrodites, imbeciles, Jukes, Kallikaks, lunatics, morons, polydactyls, runts, simpletons, twins, and Zeros; in a very broad and general sense, pathological phenomena." The evolutionists particularly make much of this. Is the criticism justifiable? Morgan who has lately raised this point meets the challenge as follows:

> The genetist knows that opposed to each defect-producing element in the germ plasm there is a normal partner of that element which we call its allelomorph We cannot study the inheritance of one member of such a pair of genes without at the same time studying the other. Hence whatever we learn about those hereditary elements that stand for defects, we learn just as much about the normal partners of those elements. In a word, heredity is not confined to a study of the shuffling of those genes that produce abnormal forms, but is equally concerned with what is going on when normal genes are redistributed. This method of pitting one gene against the other furnishes the only kind of information relating to heredity about which we have precise knowledge.

To be sure there is no superman with with the time or capacity for controlling mankind as a herd, in order to make records of reactions of his characteristics in breeding. Yet, as pictured by Karl Pearson:

> Man himself makes the experiments which are directly impossible for the eugenist. This stock marries kin for six generations; those parents surfeit themselves with alcohol, there the tuberculous talent meets insanity; here the man of genius marries into his class; there he takes a woman of the people. There is hardly a phase of nurture and of environment, and of parentage and of ancestry which cannot be followed up, not in a single experiment, but in repeated experiments, if the time and energy to investigate are forthcoming.
>
> The science of eugenics does not propose to experiment on man; it endeavors to lay before us the experiments of man on himself, and this in such numerous cases that the evidence must carry with it conviction. Our object is to form an analytical record of man's experiments on himself, to draw from the history of his successes and failures the biological laws which govern his social development, and upon the basis of the knoweldge thus gained to predict what lines of conduct foster, what lines check national welfare.

A Guide Book To Health

Why Die So Young? by John Huber, A. M., M. D. Pp. 313. New York and London, Harper & Bros. 1921.

Dr. Huber's attempt is to outline a course of living for all periods, from infancy to old age, which will result in the best possible health. Logically enough, he begins his book with a discussion of heredity, and this might have been made both interesting and useful, for a great deal of material is available on the relation of health and disease to heredity. The author's discussion is superficial and inadequate, however. The rest of the book is made up of common sense advice written in an understandable way.

P. P.

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TWINS FROM A TWIN-BEARING FAMILY

These boys came honestly by being twins. In fact, they were lucky not to have been quadruplets, for on their mother's side of the family are two cases of twinning, and on the father's side there are seven pairs of twins. Since Galton's pioneer studies regarding the similarities and differences of twins they have been of perpetual interest to students of heredity, and their popular interest antedates Galton thousands of years, at least. Later studies but serve to confirm Galton's original conclusion, "that nature prevails enormously over nurture, when the differences of nurture do not exceed what is commonly to be found among persons in the same rank in society and in the same country." (Frontispiece.)
See "Twins Again," by Albert Edward Wiggam, p. 311

THE THYROID GLAND AND DEVELOPMENT

Frederick S. Hammett

The Wistar Institute of Anatomy and Biology, Philadelphia

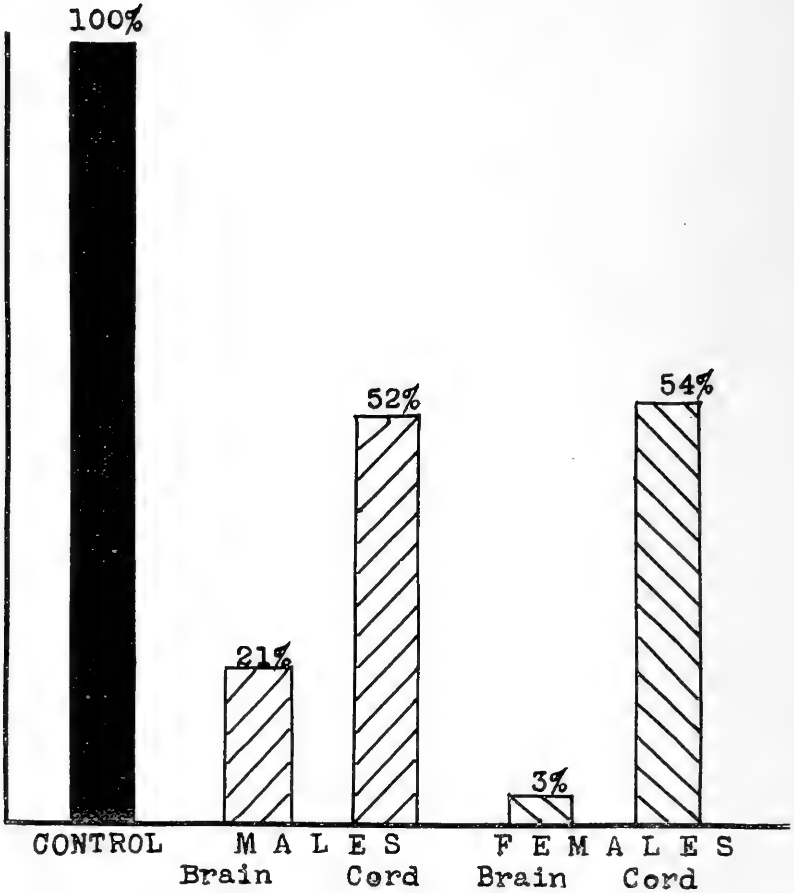
DEVELOPMENT is both qualitative and quantitative. The type and functional aspects of development are qualitative. The extent and rate of development are quantitative. Qualitative development is specific and normally fixed. Quantitative development is specific as to its limitations but is subject to variation due to the environmental influences of diet, exercise, toxemia, and so forth. The fundamental type of structure and function characteristic for a given species is what sets the species apart. The differences in extent and rate of development of individual organisms within a species are causes of the variations within the species. These variations may be proportionate or disproportionate. Proportionate variation occurs when inter-organic differential development differs in absolute but not in relative value. Such variation gives rise to a series of individuals differing in absolute size, but not in the relative sizes of the constituent parts of the individual. Disproportionate variation occurs when the rate or extent of development of one or more parts of an individual with respect to other parts of the same indivual, differ from the rate or extent of development of the same parts in another individual with respect to its other parts.

Disproportionate developmental variation gives rise to groups of individuals which for want of a better term have been designated as "types" within a species. These "types" differ from each other in bodily proportions, but the fundamental specific type is the same in all. That is to say, the qualitative development is the same, while the quantitative differential development is different. An instructive classification along these latter lines has been given by Stockard in his broad division of man into the "Linear" and the "Lateral" type of structure.

Much interesting speculation has been made of the role of the thyroid gland in "type" development of man. This, as should be clear from the foregoing, is actually a question of the part played by thyroid activity in differential development, which in turn is largely a phase of quantitative, not of qualitative development. Although it is possible that thyroid function is associated with qualitative development, there is no evidence at present available which would justify the allocation of any definite influence of that gland on this phase of growth.

On the other hand, it is possible to show that thyroid activity is a factor of great importance in quantitative differential development. It seems best, therefore, at the present time, to confine ourselves to an interpretation of known facts, rather than to attempt the elaboration of an hypothesis for which no adequate experimental data are available.

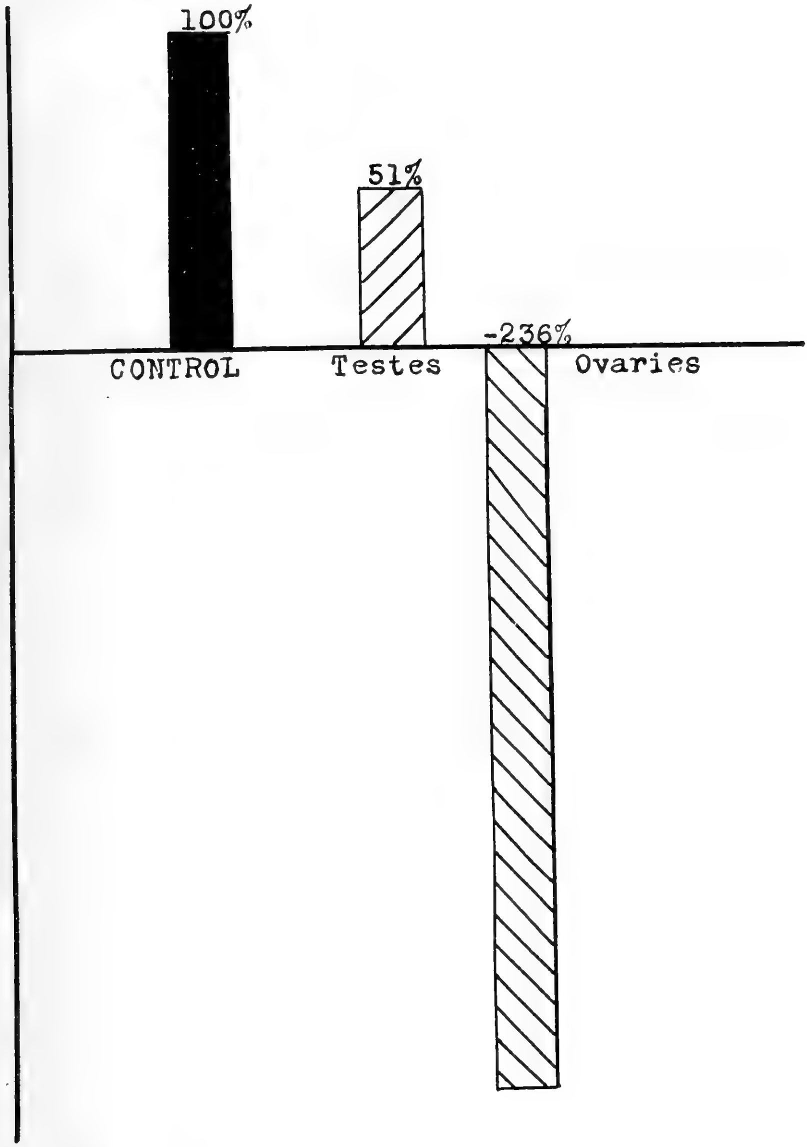
Other things being equal, quantitative development depends on the kind and amount of food ingested by the individual, although there is, of course, a specific limitation of the size to which an organism can grow. Quantitative development is thus intimately associated with metabolism. There is a certain fundamental type of metabolism common to all the living cells of the organism. It is known that a function of the thyroid gland is con-



GROWTH OF BRAIN CONTROLLED BY THYROID GLAND

FIGURE 1. In this chart the brain and spinal cord are considered as separate organs of the nervous system. The operated white rats had their thyroid glands and the parathroids removed, and the effect of thyroid removal was determined by a comparison with litter controls fifty days later. The spinal cord, which controls reflex nervous activities of the organism, represents an older and relatively less differentiated part of the nervous system than the brain, in which are centered the higher mental functions. Cretins show a nearly normal development of the "cordal" nervous reactions, but an almost total absence of cerebral functions. These experiments indicate why this should be so.

cerned in the maintenance of an adequate level of this basal metabolism. In addition to, or along with this common type of metabolism, there is evident in each individual organ a specific type which is characteristic for the organ in question in the nature of its assimilative and productive phases. The adrenals produce adrenin, the pancreas secretes trypsin, the liver assimilates glucose and stores it as glycogen, and so on. It is probable, though not yet demonstrated, that thyroid gland activity has an influence upon the specific as well as the general metabolism of the individual organs. It is, however, evident that the thyroid gland, through its relations to the metabolic processes of the body as a whole and of its parts,



EFFECT OF THYROID GLAND ON GROWTH OF THE GONADS

FIGURE 2. In these white rats the removal of the thyroid and parathyroid glands has resulted in the male gonads reaching only about half the normal development, and in actual degeneration and atrophy of the female reproductive organs. Goiter and other diseases of the thyroid are much more frequent among woman than among men, and the break-down of the thyroid coincides generally with a period of change or stress in the female reproductive system. These charts show that a much closer relation exists between the reproductive system and the thyroid in the female than in the male.

is intimately concerned with quantitative development.

Clinical observations on man and extirpation experiments on animals have established the fact that a deficient thyroid secretion results in a marked retardation of body growth. It should be noted that present evidence supports the belief that the retardation accompanying thyroid deficiency is a consequence of the lowered plane of general metabolism. The earlier idea that the thyroid gland produces a secretion specifically stimulative of growth has yet to be substantiated.

The studies of Swingle and others have demonstrated the significant role of the thyroid in differential development of amphibia in relation to metamorphosis. No systematic quantitative studies of the part played by the gland in differential development of mammals had been made up to somewhat over three years ago when I began experiments, the detailed results of which are being published in a series of papers in other journals. The plan of the investigation and the procedures employed are to be found in these communications. This paper deals with two of the striking evidences of the dependence of normal differential development on thyroid function and certain implications to be derived therefrom. The observations were made on albino rats of both sexes, adequately controlled as to litter, sex, age, diet, and environment, during the growth period from 100 to 150 days of age. The test, or thyroidless rats, were deprived of the thyroid apparatus (thyroid plus parathyroids) when 100 days of age and allowed to grow until 150 days old when they were killed and the appropriate measurements made. The values so obtained were compared with those obtained from the unoperated controls.

It was found, as others have found, that the loss of the thyroid secretion caused a marked retardation in the growth in weight of the body as a whole. That is to say, total quantitative development was retarded. In addition is was found that the retardation was not a simple proportionate retardation in which the organism at the terminal stage showed the same relative composition as the control. The various organs differed in the degree of their response to the thyroid deficiency. The various organs did not show proportionate degrees of retardation of the rate and extent of development. Disproportionate variation in the development of different organs was caused. A "type" of organism resulted which was different from the normal for the group from which the test animals came. When the internal environment was altered by the removal of the thyroid apparatus a differentiation of development obtained.

This effect is quite marked in the growth of the central nervous system, as represented by the brain and spinal cord, taken as separate organs.

In order that the effect and its extent may be made clear, there is given in Figure 1 the growth of the brain and spinal cord of the thyroidless rats in terms of the growth of these structures in the controls. The solid black column represents the growth in controls as 100 per cent. The heights of the other columns represent the degree of development of the brain and spinal cord of the male and female thyroidless rats, or the degree to which these organs failed to reach the normal level.

From the chart it is at once evident that the removal of the thyroid function does not have the same quantitative effect upon the development, as measured by the weight, of the brain as it does upon the spinal cord. The growth of the former is much more markedly retarded than is the growth of the latter. The lack of thyroid secretion caused a disproportionate variation in the differential development of these two parts of the nervous system of one and the same individual.

Effect of Thyroid Deficiency on Mentality

These observations are in line with clinical reports of the relative physical and psychic development of cretins. It is a generally accepted theory that cretinism is a result of deficient thyroid activity. This theory is based on the fact that a high incidence of thyroid disturbance, as expressed by thyroid hypertrophy, is usually found in the region where cretinism exists, and that certain post-mortem examinations of cretins show either the entire absence of functioning thyroid tissue, or a thyroid gland of very small size and abnormal structure. One of the marked characteristics of the cretins is the low mentality and usually small size of the skull cavity and brain. These individuals also show a retardation of general growth. However, from a standpoint of function, their physiological and reflex activities as mediated by the spinal cord, are apparently present in the normal state of development, while their psychic or cerebral potentialities are decidedly underdeveloped.

It is hazardous to associate size development with functional development in a heterogeneous stock. The rats which were used in my experiments, however, came from a stock which was highly homogeneous and the controls were litter controls. It is, therefore, not an expansion into improbability to consider that along with the greater retardation of brain growth there was a greater retardation of brain function. If this assumption is correct the differential effects on the central nervous system of thyroid deficiency experimentally produced in albino rats, are quits analogous to the effects of a thyroid deficiency on the same structures in cretins.

The Thyroid and Sex

In addition to the difference in retardation of brain and spinal cord in one and the same animal there is exhibited a sex difference in that in the females the retardation of the brain is more marked than in the males. It might be noted here that this sex difference in developmental rate is not confined to the brain but is a general phenomenon exhibited by practically all the organs.

This sex difference is shown in the greatest degree in the response of the gonads to the thyroid deficiency. The development of the testes and ovaries of the thyroidless rats is given in Figure 2 in terms of that of these organs in their respective controls.

It is evident that the development of the male gonads is but little retarded by the lack of thyroid secretion, while the development of the female gonads is not only absolutely inhibited, but retrogressive changes occur and weight is lost. The actual values mean that the growth of the testes in the male thyroidless rats was fifty-one per cent of that of the controls for the same age period, while the ovaries of the female thyroidless rats actually lost in weight over twice as much as was gained by their controls.

This specific sex difference points to the reason why thyroid disturbances, particularly goiter, are more frequent in women than in men. Clinical observations show that coincident with alterations in the physiological activity of the ovaries, such as occur at puberty, menstruation, pregnancy, and the menopause, there are often changes in the size of the thyroid. No such cyclic changes in thyroid size have been demonstrated in men. Correlating these phenomena with those observed in the developmental differences in the gonads of the two sexes in the albino rat, it is evident that in the male there is little interrelationship between the thyroid gland and the testes, while in the female a high degree of association is shown to exist.

This difference in response of the gonads of the two sexes to the thyroid function suggests that if thyroid defects are transmissible, the line of

influence is largely through the female. This idea is pure speculation. The data now available do not even justify the setting up of an hypothesis but the possibility deserves investigation.

We have seen from the foregoing that the quantitative aspect of development is dependent upon thyroid gland function. When this is lacking the extent and rate of development are not only retarded but become disproportionate and a different structural "type" of organism is produced within the species, the qualitative development of which apparently remains the same.

In view of these facts, it is not hard to believe that differences in thyroid gland activity play a significant role in the determination of some of the various human structural types. Circumstantial evidence leads us to believe that environmental influences are powerful factors in the determination of the level of thyroid gland activity. Diet, type of intestinal flora, and emotional contacts are apparently factors of importance. The direct effect of these acting through the thyroid on bodily structure during critical periods of development, complicates the estimation of the intensity of the factors of heredity in the determination of the adult structure. This is so because a disproportionate variation in development within a species may as well be due to an environmental influence changing the level of thyroid gland activity, as to a difference in the relative intensity of the inherited factors which determine the structural type of the species.

Social Conflict and Education

PURELY as a magnificent example of inductive reasoning, James Mickel Williams' *Principles of Social Psychology*[1] is admirable. The reader enjoys the mastery of scientific method, the induction of abstract conclusions from concrete examples, generalizations from particular cases.

But he inherent importance of examples and conclusions greatly surpasses their judicious use in a process of reasoning. The material Professor Williams so effectively uses forms the basis for a study of conflict in modern social organization. It is the author's purpose to analyze that conflict, looking into its causes, manifestations, and effects in the components of our present social structure.

The "psychology" of the study comes first of all in the analysis of the forces in individuals that cause conflict. These motives Professor Williams is pleased to group into several types of "dispositions" according to the predominance of one trait over others. The group includes the rivalrous, the dominating, the fearful, the sympathetic, the intellectual, dispositions. In modern phraseology Professor Williams characterizes human nature no less delightfully and aptly than the classical Greeks sketched types of men of olden days.

"Sociology" is joined with "psychology" in the exposition of these dispositions at work under the conditions of our social fabric. We see the conflict of interests in economic relations, in political relations, in professional relations, in family, cultural, educational relations, and the reactions of suppressed impulses on all these aspects of social organization.

This analysis is not always gratifying to our vanity. Another author might have made of the same material a caustic, repellent attack on social institutions. But Professor Williams'

(*Continued on Page* 322)

[1] WILLIAMS, JAMES MICKEL. *Principles of Social Psychology.* Pp. 400. Price $3.50. Alfred A. Knopf, New York, 1922.

HERITABLE CHARACTERS OF MAIZE

XV—Germless Seeds[1]

M. Demerec

Station for Experimental Evolution, Cold Spring Harbor, N. Y.

IN the winter of 1922 a peculiarity was noted on the germinal side of several seeds taken from a selfed ear. Closer observation revealed the fact that these seeds lacked the germ. The ratio of normal and germless seeds taken from the same ear indicated that the germless condition might be an inherited character. Further observations established this fact and gave the results presented below.

Description of Germless Seeds

As far as size and shape are concerned the germless seeds are normal or practically normal. When examined from the side opposite the germ in most cases they cannot be distinguished from normal seeds. When viewed from the germinal side the difference between the normal and germless seeds can be readily detected. The germinal area of a germless seed is without a sharp margin. It is more sunken than in a normal seed and is covered with wrinkled pericarp, which looks translucent because of air cavities below. If a germless seed is split vertically a cavity is found in the place where the germ is normally located. The difference between the normal and germless seeds can be seen from Figure 3.

When a seed with sugary endosperm is germless, the germinal area is still less distinct and in many cases the germinal and opposite sides can hardly be distinguished.

From the observed ratios it can be concluded that the germless condition is a result of the union of two gametes both of which are carrying necessary recessive factors. The fertilization is apparently accomplished and the development of the endosperm proceeds normally, but the development of the embryo is stopped in some early stage of its growth. Up to this time only mature seeds have been examined. In some of them only traces of an embryo could be detected; in others no signs of a developing embryo could be seen.

Inheritance of Germless Seeds

No special crosses were made for the study of the inheritance of germless seed. It was possible, however, to trace the behavior of the character through several generations, because it was found in several families grown for the genetical study of other characters.

A 63:1 Ratio—Three plants had been pollinated with the pollen from a Golden Bantam sweet corn plant, which was apparently heterozygous for germless. Part of the first generation ears grown from these crosses had all seeds normal, and the other part segregated into normal and germless, with the totals given in Table I.

A plant from family 311 was crossed with another plant from a different family which did not throw germless seed. Part of the second generation ears were normal and the other part segregated as shown in Table II.

The occurrence of 63:1, 15:1 and 3:1 ratios in the progenies of the crosses made by the pollen from a single plant and its progeny, indicates that in this case the homozygous condition of at least three genes was necessary for the expression of the germless character.

[1]Paper No. 111, Department of Plant Breeding, Cornell University, Ithaca, New York.

A 9:7 Ratio—A plant of the Bodwick variety grown from seed obtained from the Montana Experiment Station was crossed with another plant from a family grown for several years at Cornell for genetical studies. Both of these plants were selfed and both segregated for germless in a 3:1 ratio. The first generation from this cross had all seeds normal and the second segregated as shown in Table III.

The occurrence of a 9:7 ratio in the second generation shows that two independent factors for germless were present in this cross. The germless characters present in the parents were phenotypically alike, but genetically different.

Conclusions—From the data obtained it can be concluded that the germless phenotype may be expressed by several genetically different factors. The evidence presented shows that at least four different factors were present in the families discussed above. Three of them are triplicate genes and the fourth one, as far as it is known, acts as an independent factor.

Frequency of Germless Seeds Among Cultivated Varieties of Maize

Several commercial varieties of corn were recently included in the stocks grown for genetical studies, because they possessed some seedling characters of genetical interest. Progenies of those varieties which were selfed for two or three generations have been examined for the germless character. It was found that selfed progenies from about seventy-five per cent of the commercial varieties examined had some germless seeds. The ratio in which the germless character segregated was different in different varieties, as can be seen in Table IV.

Among inbred varieties grown at Cornell for breeding purposes, Professor R. G. Wiggans observed germless seeds in the following: Cornell II, Alvord's White Cap Yellow Dent, Onondaga White, and Latting's Red Cob White.

Summary

An inherited character called germless (*Gm gm*) is described. In germless seeds the endosperm is developed normally but the embryo is almost or entirely lacking.

The germless condition is recessive to normal. Segregations in 63:1, 15:1, 3:1 and 9:7 ratios were observed, which indicates the presence of at least four genetic factors for germless. Three of them are triplicate genes.

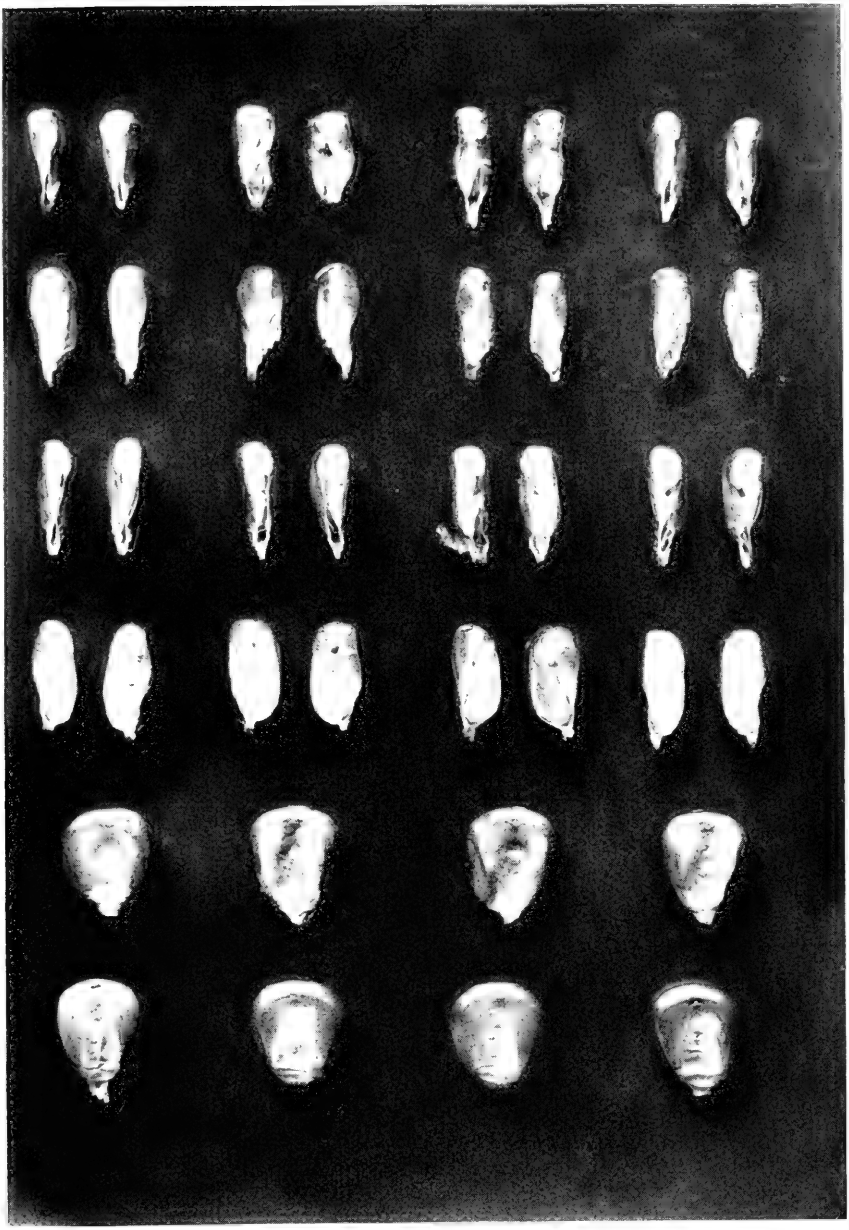
Germless seeds were found in the majority of commercial varieties of which selfed progenies were examined.

TABLE I—*Data regarding the segregation of ears for germless seeds in the first generation of certain crosses of Golden Bantam sweet corn.*

Family No.	Normal	Germless	Total	Ratio	Expected Germless	Difference
311	932	19	1055	63:1	16.4	2.6 ± 2.70
312	792	55	847	15:1	53.0	2.0 ± 4.46
313	142	2	146	63:1	2.2	.2 ± 1.01
313	35	2	37	15:1	2.3	.3 ± .99

TABLE II—*Segregation in second generation of heterozygous germless strain × normal.*

Family No.	Normal	Germless	Total	Ratio	Expected Germless	Difference
855	569	163	732	3:1	183	20 ± 7.9
855	679	44	723	15:1	45.2	1.2 ± 4.9



GERMLESS AND NORMAL SEEDS IN MAIZE

FIGURE 3. Alternate rows show germless and normal seeds, the second, fourth and sixth rows from the top being normal seeds; first, third and fifth rows, germless seeds. The upper four rows show longitudinal sections of the seeds through the embryo. The third and fourth rows show seeds that have been soaked in water for twenty-four hours. The first and second rows show dry seeds in section. Note the cavity in the germless seeds, and how little change has been produced in them by soaking as compared with the normal. Germless seeds have been observed in a number of variaties of maize, but the character is not inherited in the same way in all of them.

TABLE III—*Segregation in the second generation of a cross between two strains of maize heterozygous for germless seeds.*

Family No.	Normal	Germless	Total	Calculated Germless	Difference
			(3:1 Ratios)		
814-1	150	59	209		
-9	191	69	260		
Total	341	128	469	117.25	10.75 ± 6.32
			(9:7 Ratios)		
814-11	80	49	129		
-12	120	79	199		
Total	200	128	328	143.5	15.5 ± 6.08
			(All Seeds Normal) 814-8, -13, -15		

TABLE IV—*Ratios observed in segregation of germless seeds in commercial varieties of maize.*

Family No.	Name and Origin of the Variety	Ratios Observed
349	High Protein Strain from S. Dakota Exp. Sta...	15:1, 3:1
789	Low Ear Strain, S. Dakota Exp. Sta.........	63:1
787	Parson's Dry Land Corn, Montana Exp. Sta....	(71:15)
790	Wisconsin No. 10, Montana Exp. Sta.........	15:1
792	Fort Totten Indian Corn, Montana Exp. Sta.....	3:1
345	Bodwick, Montana Exp. Sta.	3:1
336	South American Corn, Dr. D. F. Jones......	15:1, 3:1
333	Pseudo Starchy Corn, Dr. D. F. Jones.....	15:1
344	Early Canada Flint, Mr. Breck	15:1, 3:1
791	Pride of the North Yellow Dent, Isbell Seed Co., Jackson, Mich....	3:1
451	Dulton's Flint...........	63:1, 15:1
311-313	Golden Bantam.....	63:1, 15:1, 3:1
613	Luce's Favorite.........	15:1, 3:1

The Old American Stock

INCREASE OF POPULATION IN THE UNITED STATES 1910-1920: A study of changes in the population of divisions, states, counties, and rural and urban areas, and in sex, color, and nativity, at the fourteenth census, *by* WILLIAM S. ROSSITER. Census Monographs No. 1, pp. 255. Washington, D. C., 1922.

Information contained in many large volumes of the latest census has been condensed into this volume, intended for a more popular presentation of the facts. It will be almost indispensable to those interested in the population of this country, for it goes far beyond its title, and includes comparisons on many points as far back as the first census.

To a eugenist perhaps the most interesting feature are the calculations attemping to determine what part of the present population is descended from people who were living in the United States in 1790. Briefly, it is figured that perhaps 20,000,000 of the present inhabitants are of absolutely pure native white stock, while possibly twice as many more have a larger or smaller amount of the same "blood."

P. P.

PROLIFIC AND OTHER DWARF OATS

Dominant Dwarfness Observed in Two Oat Crosses

T. R. Stanton

U. S. Department of Agriculture, Washington, D. C.

DWARF OATS DOMINANT TO NORMAL

Figure 4. Progeny rows grown at Aberdeen, Idaho, in 1922 from eight prolific dwarf plants found in 1921 in a nursery row of the Aurora × Pringle Progress cross. Note the two normal tall plants in the fifth row from left. The dwarfs appeared in the sixth hybrid generation of the cross. It is possible that the two tall plants may have resulted from accidental admixture of seed. Further genetic studies of them and of the dwarfs would be necessary to determine this. If the tall plants prove to be the result of segregation it will mean that the dwarf character is dominant, which is exactly the reverse of what has been observed in other crosses with oats.

In a nursery row of oats grown at the Aberdeen Substation, Aberdeen, Idaho, in 1921, eight plants of an early, prolific dwarf oat appeared. The plants in this row were grown from a selection of a cross between the Aurora and Pringle Progress varieties. This cross was made by the writer in the greenhouse at Arlington Experimental Farm, Rosslyn, Va., in the spring of 1916. Only one crossbred seed was obtained. This was sown in the greenhouse in the fall of 1916, and produced a vigorous plant. Seed from this plant was sown in a five-foot row at Aberdeen in the spring of 1917 and produced nineteen second generation plants. These were harvested individually and sent to Washington by C. W. Warburton, then agronomist in charge of oat investigations. In the spring of 1918 seed from each second generation plant was sown at Aberdeen in individual five-foot rows, producing at harvest approximately 500 third generation plants. Of the nineteen progenies nine were considered as being homozygous, and were harvested in bulk Among these nine, No. 1019 a1-12B was included, in which

the dwarfs appeared in 1921. Of the remaining ten, five were discarded and further selections were made from the others. These third generation progenies, including the nine bulked strains and the reselections, again were grown in five-foot rows at Aberdeen in 1919. In 1920 the strain 1019 a1-12B, along with twenty-four others of this cross, were advanced to the rod-row nursery at Aberdeen. At harvest time these rows were cut in the usual manner, but no dwarfs were noted in the row of 1019 a1-12B. In 1921 these same strains were once more included in the rod-row nursery at Aberdeen, and at harvest the eight dwarf plants were observed in the row of selection 1019 a1-12B, the dwarfs thus appearing in the sixth hybrid generation of the cross.

Progeny of the Dwarf Plants

The eight dwarf plants were harvested individually and sown in five-foot rows at Aberdeen in the spring of 1922. The eight plants bred true for dwarfness, with the exception of one row, in which two tall plants appeared. It is possible that these two plants were accidental mixtures and not plant segregates. One was yellow-seeded like the Aurora parent, and the second was black-seeded unlike the other parent, Pringle Progress, which is a white oat. To determine the genotypic make-up of the two tall plants, individual progenies from them will be grown in 1923, as well as from the dwarfs in this row. The eight dwarf mother plants produced about 230 dwarf plants.

One of the most interesting things about this dwarf is its prolificacy. Practically every culm produced a small panicle with numerous spikelets. The plants were distinctly turf-like, in which character they were similar to the dwarfs from Victory oats, described by Warburton.[1] However, in earliness and prolificacy it is distinct from the Victory dwarf. This new dwarf is quite early and produces fully ripened grain in abundance, while the Victory dwarf is very late and barely ripens sufficient seed to reproduce itself. The prolificacy of the dwarf plants grown at Aberdeen in 1922 is shown in Figure 4.

The genotypic composition of the dwarf form has not been determined by crossing it with the normal tall, but it is possible that it will behave as a pure recessive, as was the case in the dwarf reported by Warburton. The fact that it was not found until the sixth hybrid generation may be due to its having been masked in some unknown manner, becoming apparent only after proper recombination of factors had occurred. On the other hand, if the two tall plants appearing in the progeny of the one dwarf plant are the result of segregation a condition directly the reverse of that shown by Warburton is evident, that is, the tall character must be considered as recessive and the dwarf character as dominant. It also is possible that the dwarfs may be mutations, or that they may be due to some combination that is not simple in nature. That the condition is complex is evidenced by the dwarfs not appearing in generations earlier than the sixth.

Dwarfness in Other Hybrids

In 1921, dwarf oats also appeared at Aberdeen in the progeny of another cross. The plant material in which this dwarf appeared represented the fourth generation progeny of a cross between Winter Turf and Sixty-Day. In all, eight progenies of this cross were grown in plant rows at Aberdeen in 1921, which represented plant selections from third generation material. Of these eight progenies, three produced one dwarf plant each. The number of dwarf and tall plants produced in the three segregating rows in 1921 is shown in Table 1.

[1] Warburton, C. W. The Occurrence of Dwarfness in Oats. *Jourl. Amer. Soc. Agron.*, xi:72-76. 1919.

ANOTHER CASE OF DOMINANT DWARFNESS IN OATS

FIGURE 5. Progeny of one of the mother-dwarfs from the Winter Turf × Sixty-Day cross. Note the normal (tall) segregates in row with dwarfs. Rows in foreground were cut away to show dwarfs. The evidence that the dwarf character in this cross is dominant is more conclusive than in the case of the prolific dwarf (Figure 4).

In 1922, progenies from the three dwarf and nineteen of the fifty-two tall plants were grown in individual five-foot rows at Aberdeen. The nineteen tall plants from selection 1009 b2-20-3-5 produced approximately 450 tall plants and no dwarfs, thus showing a homozygous condition for the tall character. Seed of the tall plants from the other two dwarf-producing progenies of 1921 was not sown individually in 1922, but in bulk. One panicle was taken from each plant, thus making a composite sample of seed. From this seed approximately 200 plants each from selection 1009 b2-20-3-6 and 1009 b2-20-3-7 were grown in 1922. These rows were carefully inspected but no dwarfs were found.

As to the behavior of the progenies of the dwarfs, the number of tall and dwarf plants produced by each is shown in Table 2.

According to the data shown in Table 2, the three dwarf plants produced in 1921 were heterozygous. They produced a progeny of seventy-five dwarf and twenty-two tall plants, thus showing an approximate ratio of three to one. The interesting feature in this connection is that the dwarfs are heterozygous, rather than the tall plants, indicating a condition similar to

that possibly existing in the prolific dwarf previously described, provided the tall plants appearing in the progeny of the one plant were the result of a recombination of certain factors instead of accidental admixtures. These data indicate that the dwarf character is dominant, and the tall character recessive. This condition, therefore, is directly the reverse to that shown by Warburton in the dwarf plants from Victory.

The three mother-dwarf plants produced in 1921 as well as the seventy-five grown in 1922 were decidedly late in maturity and not very prolific. The progeny of one of the dwarf plants is shown in Figure 5. In most characters they resemble very closely the dwarfs described by Warburton.

Discussion of Results

Assuming that the two tall plants appearing in the relatively large dwarf progeny from the Aurora X Pringle Progress cross were accidental mixtures, and that the dwarf character in this cross behaves as a pure recessive, there still remains some explanation to be made of the directly reversed behavior shown in the progeny of the dwarf plants from the Winter Turf X Sixty-Day cross. One explanation for the appearance of the apparently heterozygous dwarf is that it arose as a result of a mutation affecting either the pollen or egg cells of a normal plant and resulting in the genotypic make-up D^d d^d, for the dwarf, assuming that D denotes the presence of the factor for dwarfness. In the next generation this would produce the following:

1 D^d D^d 2 D^d d^d	Dwarfs 3
1 d^d d^d	Normal 1

thus giving a simple Mendelian monohybrid ratio of three dwarfs to one tall, as indicated by the data in Table 2. The origin of the heterozygous dwarf possibly is not so simple as the above explanation would indicate.

In order to obtain additional data on the behavior of this dwarf, individual progenies of all plants producing seed from the three segregating rows will be grown in 1923. The segregates homozygous for dwarfness will thus be determined. These then will be back-crossed on the homozygous talls in an attempt to determine the various factors involved in the production of the heterozygous dwarf.

Miyazawa[2] very recently has reported similar hereditary behavior of a dwarf form of barley in which the dwarf character is dominant and the dwarf plants are heterozygous, a pure dwarf condition apparently being lethal. He obtained a ratio of approximately two dwarfs to one normal, instead of a ratio of three to one, from which he concluded that typical segregation was not shown. In further investigations with this dwarf he discovered among his seedlings a new dwarf form (a sterile dwarf) which tillered freely, but grew very slowly and produced no seed, the length of the culm being markedly shorter than that of the original or non-sterile dwarf. Of 684 plants grown he classed 156 as sterile dwarfs, 340 as non-sterile dwarfs, and 188 as normal, the ratio of the three types thus being approximately 1:2:1. The original dwarf found in 1915 was described as being intermediate externally, that is, shorter than normal, but taller than the sterile dwarf. Theoretically he concludes that if the allelomorph for dwarfness and absence of dwarfness is denoted by D and d, respectively, the sterile dwarf = DD, the normal =dd, and the ordinary dwarf = Dd. On the basis of this explanation he suggests that the seed which first produced the dwarf plant, Dd, may have arisen from dd by mutation.

[2] MIYAZAWA, BUNGO. Hereditary Behavior of a Dwarf Form of Barley in Japan: *Jourl. Genetics,* xi:205-208; 1 plate, Cambridge, Dec. 1921.

TABLE 1. *Number of tall and dwarf plants obtained from the three segregating rows of the Winter Turf X Sixty-Day cross, grown at Aberdeen, Idaho, in 1921.*

Row No. 1921	*Hybrid No.*	*Number of Plants* *Tall*	*Dwarf*
897	1009 b2-20-3-5	19	1
898	1009 b2-20-3-6	16	1
899	1009 b2-20-3-7	17	1
	Total	52	3

TABLE 2. *Segregation of the three dwarf plants from a cross between Winter Turf and Sixty-Day oats grown in plant rows at Aberdeen, Idaho, in 1922.*

Row No. 1922	*Hybrid No.*	*Number of Plants* *Tall*	*Dwarf*
486 and 487	1009 b2-20-3-5	7	36
507 and 508	1009 b2-20-3-6	11	22
517	1009 b2-20-3-7	4	17
	Total	22	75
	Approximate ratio	1	3

A New Edition of "The Livestock of Great Britain"

FARM LIVESTOCK OF GREAT BRITAIN, *by* ROBERT WALLACE, assisted by J. A. SCOTT WATSON. Fifth edition. Oliver and Boyd, Edinburgh, Tweeddale Court. 1923.

Since the first edition of Professor Wallace's book appeared in 1885 it has been recognized as the standard work on its subject. The fifth edition has just been issued. It has been revised and considerably enlarged with the assistance of Professor J. A. Scott Watson, Mr. Wallace's successor as Professor of Agriculture and Rural Economy in the University of Edinburgh.

The first chapter presents a condensed but sound discussion of the modern theory of heredity and its application to livestock breeding. The greater portion of the 868 pages are devoted to the discussion of the origin, development and present characteristics of the British breeds of livestock. An enormous body of facts are presented in thoroughly readable style. Chapters in the book deal with the management of the various kinds of livestock and with their diseases and with the home or first aid treatment of these.

One of the most valuable features of the work is the abundance of excellent illustrations, 442 plates and 111 text figures. We find, for example, no less than 28 photographs of Shorthorn cattle admirably chosen to illustrate the various types, Scotch, Booth, Bates, milking type, etc. These photographs and those of the other breeds will repay hours of study. Altogether the book is one which should be familiar to all who are interested in the improvement of livestock.

S. W.

A HANDBOOK OF HUMAN BIOLOGY

A Review

HUMANISTS often are jealous of the pigs, calves or cabbages in the belief that more careful, scientific study has been given to the plants and animals than to the human breed, and that more definite information is available upon the proper handling of crops and herds than upon the nurture and education of children. This feeling will not be allayed by a reading of the present work,[1] but progress is made through every recognition of the need of developing the human side of biology, and the present effort to supply this enormous deficiency should be highly appreciated. The result is a notable achievement that must find a place in all working libraries that include general biology and the social sciences.

People are more important than plants and animals, and partly for that reason are much more difficult to study scientifically, because regular experimental methods are not applicable to normal human populations, rarely even to a few individuals. Hence the biological data of humanity are restricted largely to observation and inference, which are much more difficult to make and to interpret correctly than to secure corresponding experimental data from other species that can be placed under controlled conditions. From any agricultural standpoint the human crop must be reckoned as a failure if we consider how few of our young men and women attain, or even approach, the full standard of their possibilities of development. We are becoming conscious of the limitations of our educational system but lack the knowledge and understanding that are necessary to devise practical ways to change it.

As it is necessary to go outside civilization and live with savages in order to begin properly to appreciate civilization, and to understand what civilization is, so it is necessary to go outside of man to the life of animals and plants, in order to see more clearly what is peculiar to man, and thus to gain a more practical consciousness of human development, racial and individual. Most of the animals and plants are easily found and studied in the wild state, so that we may know their original habits and the conditions and the limiting factors of their development, but we have only fragmentary data and slight understanding of the biology of primitive man.

Though our author has little to say directly of eugenics, which consciously has figured very little in the past of human development, the eugenic position is powerfully supported by a world-wide collection of facts relating to human existence, and showing that in one form or another, natural, political, economic, social or religious, there have been selective checks to reproduction, working through all the ages and stages of human progress, and tending in direct or different ways to strengthen or to weaken the tendencies of human development. What we begin to see as we become more conscious of the sorting processes of the present age, is that civilization may suspend or reverse the conditions of natural selection that tended always to the further improvement of the race, and establish forms of negative or adverse selection. If special ability and higher education do not have greater survival value, so that the capable are more likely to marry and to raise larger families than less capable and less educated people, a condition of negative selection must

[1] CARR-SAUNDERS, A. M. *The Population Problem, a Study in Human Evolution.* Pp. 516. The Oxford University Press, New York, and London, 1922.

be admitted as evidence that our present system is unbiological and self-destructive.

Since eugenics as a practical investigation needs to begin with a conscious and constructive recognition of the biological forces that have been active in the past, and have brought us where we are, such a survey of the data of human development is a fundamental contribution to eugenics. Though the standpoint of the present work might be described as Malthusian, in the sense of reckoning human fecundity as normally in excess, and often outrunning the economic development of primitive peoples, this has no relation to the birth control vagaries of Malthusianism. That some of these notions have had the support of John Stuart Mill and other well-known names only shows the greater need of scientific recognition and study of the population factors.

Following a critical historical review of previous studies of population, data are assembled from many fields of inquiry, anthropology, ethnology, psychology, pathology, history, politics, and education. Conditions of primitive and prehistoric life are considered for fishing and hunting tribes, and for early agricultural stages, contrasting with urban and industrial conditions of the historical periods, ancient, mediaeval, and modern. How fecundity is restricted and regulated among primitive peoples by the conditions of existence and by mental habits, social customs and religious beliefs, all working automatically and unconsciously as checks on population, is outlined and documented to an extent that can leave no doubt of the vast importance in former times of many factors of selective elimination.

That most of these primitive selective factors have become almost entirely ineffective in the present state of civilization, but have not been replaced by any other system for maintaining the quality of the human organism, is a most disquieting aspect of human biology. Though it may be doubted or denied that selection is strictly and properly considered as a cause of evolution, there is no such doubt or denial of the power of negative selection, to weaken or destroy any special character or ability that for any reason is excluded from reproduction. If the effect of civilization is to preserve the weak and incapable while the strong and able stocks are consumed in leadership or otherwise excluded from reproduction, the quality of the race must decline, so that the decay of civilization can be reduced to a simple biological formula of negative selection. This is going somewhat beyond our author, though not out of line with his argument.

Later chapters of the book are especially needed by those extreme eugenists whose zeal for germinal improvement leads to a disregard of the environmental and educational factors of development. The last three chapters, on "tradition" are very valuable in their clear recognition of what so many writers on history and education leave out of account, that the "tradition" or carry-over of experience and opinion from each generation to the next is the chief factor in developing or maintaining civilization. Our author does not seem to see as clearly as he might that the problem of "tradition" is the problem of education, or that an over-developed institutional system of education is not an adequate vehicle for "tradition," but tends rather to separate and reduce the contacts between the generations.

The peculiar relation of agricultural life to the development of civilization in providing the full contacts between the generations that are necessary for developing and maintaining civilizations are also not recognized with sufficient clearness, though the treatment of Payne's "History of the New World Called America," is followed in trying to place history on an agricultural basis. Even Payne's mistake of supposing that rice originated in America figures in the discussion of primitive agricultural conditions in America.

Many special features of the work

would be of interest from the standpoint of current discussions, but a single example must suffice. A complete negative is given to an idea frequently indulged by writers on the oriental problem, that a solution may be found in emigration, to relieve the pressure of population. This belief appears altogether unwarranted when account is taken of the rapid rate of increase that must be expected and the very brief period that would be required to fill up Japan or China, or the whole of Asia, and the other continents as well.

EUGENICAL STERILIZATION

A Review

ORGANIZED interest in eugenics in the United States goes back little more than twenty years. As an outgrowth of the activity started by the rediscovery of Mendel's Laws, the American Breeders' Association was organized in 1905 (its name being changed in 1913 to American Genetic Association); and in the following year it created a committee on eugenics, which a few years later was elevated to the position of a section.

Even before this—namely, in the first part of 1905—the Pennsylvania Legislature had passed the first sterilization law, and thus started a movement which has ever since been, in the minds of some people, largely synonymous with eugenics.

The Pennsylvania bill was vetoed in an ignorant and facetious message from Gov. Samuel W. Pennybacker; but two years later Indiana adopted a similar measure which was put into effect.

In 1911 the eugenics section of this association formed a committee "to study and report on the best practical means for cutting off the defective germ-plasm in the American population." The late Bleecker Van Wagenen was chairman of this committee; H. H. Laughlin, superintendent of the Eugenics Record Office at Cold Spring Harbor, Long Island, as secretary of the committee immediately began a study of the subject,[1] which he has continued for the past twelve years, until the body of material he has accumulated has been published,[2] in the form of a report of the psychopathic laboratory of the municipal court of Chicago. It forms by far the most complete and factual study of the subject that has been made, and must stand for a long time as the standard work of reference in this field.

Meanwhile, fifteen states have adopted sterilization laws at one time or another, and in a dozen of these states, operations, to the total number of 3,233 (data as of Jan. 1, 1921) have been performed. Dr. Laughlin summarizes the status of the laws as follows:

> Among the 15 states which have enacted eugenical sterilization statutes the law is still on the statute books, unattacked by the courts and therefore available for use, in the following nine states: California, Connecticut, Iowa, Kansas, Nebraska, North Dakota, South Dakota, Washington, and Wisconsin. California, Connecticut, Kansas, Iowa, and

[1] A preliminary report was made by Mr. Van Wagenen at the First International Congress of Eugenics (London, 1912); a second report was published in two bulletins of the Eugenics Record Office in February, 1914: "The Scope of the Committee's Work" (Bulletin 10-a), and "The Legal, Legislative and Administrative Aspects of Sterilization" (Bulletin 10-b), both written by Dr. Laughlin.

[2] EUGENICAL STERILIZATION IN THE UNITED STATES, by HARRY HAMILTON LAUGHLIN, D. Sc. Pp. 502. Published by the Psychopathic Laboratory of the Municipal Court of Chicago, December, 1922.

Washington, have each enacted more than one eugenical sterilization statute.

In California and Nebraska the law is functioning in a very satisfactory manner. In Connecticut, North Dakota, and Wisconsin, similarly, the law is being applied in a satisfactory manner, but to a very limited extent. In Washington and Nebraska special executive machinery of proved competency is entrusted with the enforcement of the sterilization law. In Kansas and Iowa it has fallen into disuse. In South Dakota the statute is practically a dead letter.

In Iowa the law of 1913 was declared unconstitutional; it was repealed and re-enacted in new and, apparently, constitutional form, in 1915. In New York the law was declared unconstitutional by the courts (1918) and repealed (1920), but has not yet been re-enacted by the legislature. In New Jersey, Nevada, Michigan, Indiana, and Oregon, the laws were declared unconstitutional by the courts but are still on the statute books, dead letters. In the state of Washington litigation resulted in upholding the constitutionality of a very drastic eugenical and punitive sterilization law.

Eugenical sterilization laws have been vetoed by the governors of Pennsylvania (1905, 1921), Oregon (1909), Vermont (1913), Nebraska (1913), and Idaho (1919), subsequently, however, Oregon (1917) and Nebraska (1915) enacted successful laws. In Oregon, also, a former sterilization law was revoked (1913) by referendum.

Under the law thus far there have been eugenical sterilizations in only state institutions for (1) the insane, (2) feebleminded, and (3) criminalistic. No eugenical sterilization operations have thus far been performed in—

(a) State institutions for the (1) inebriates, (2) diseased, (3) blind, (4) deaf, (5) deformed, (6) dependent, (7) epileptic, nor in

(b) County, municipal, or private institutions for any type of the socially inadequate, nor

(c) Among the socially inadequate and cacogenic individuals in the population at large.

Analyzing the data from another point of view, there have been altogether 124 state institutions legally authorized to perform sterilization operations, or which 31 have made more or less use of their authority, while 93 have not. At the present time (i. e., Jan. 1, 1921) there are 70 state institutions legally entitled to the practice. The number of operations performed, by classes, is:

Feebleminded	403
Insane	2,700
Criminalistic	130
Total	3,233

By states, the operations are divided as follows:

California	2,558
Connecticut	27
Indiana	120
Iowa	49
Kansas	54
Michigan	1
Nebraska	155
Nevada	0
New Jersey	0
New York	42
North Dakota	23
Oregon	127
South Dakota	0
Washington	1
Wisconsin	76
Total	3,233

It thus appears that a single state is responsible for the great bulk of the operations listed; and in this state a single institution (the state hospital for the insane at Patton) is responsible for 1,009 cases.

Dr. Laughlin publishes the texts of all the laws, past or present; the veto messages where such action was taken; the briefs and decisions in all litigation on the subject; opinions by attorneys-general and others; together with a handy analysis of all this material. He also presents his idea of a model sterilization law, with the necessary forms for putting it into effect.

A chapter of eleven pages is devoted to a review of evidence and testimony (mostly the latter) as to the physiological and mental effects of sexual sterilization. Unfortunately, no satisfactory evidence is presented on one of the most important phases of the whole subject, namely, the supposition that the release of sterilized individuals with feeble inhibitions or anti-social tendencies is simply equivalent to the creation of so many new and virulent

foci of dissemination of venereal diseases and promiscuity.

Many collateral data of interest are recorded, such as a list (with bibliographical references) of all the traits in man which have been shown or supposed by one or another investigator to be hereditary; a list of institutions and organizations particularly concerned with eugenics; and tables showing the probable results of different types of mating.

Dr. Laughlin's analysis of the state laws now in force shows that none of them is free from defects, and some of them are definitely bad from the point of view of the biologist. He believes that the right of the state to pass and enforce a eugenical sterilization law is pretty certain; it is not so much now a question of constitutionality as a question of policy. It is probably a fair deduction from the facts he presents, that eugenical sterilization laws are gradually losing interest for the public, and to some extent at least for professed eugenists. They may have legitimate application in certain directions, as among the insane, but for the most part it has come to be recognized that persons of a markedly defective type ought to have life-long custody with separation of the sexes,—that it is not fair either to them or to to society to set them free, sterilized or not, and expect them to hold their own with the normal members of society. But if they are thus in custody, sterilization is quite unnecessary because useless.

—Paul Popenoe.

Female Pure-Bred Livestock Shows Rapid Increase

When farmers adopt pure-bred sires to head their herds and flocks it is not long before the percentage of pure-bred females increases notably. This encouraging tendency toward more rapid improvement of live stock has been brought out by the United States Department of Agriculture in the "Better Sires—Better Live Stock" campaign.

Of a total of more than 200,000 female animals listed by farmers who have agreed to keep nothing but pure-bred sires, more than 35 per cent are of pure breeding. On these farms scrubs have practically disappeared. For the larger animals the reports show that only 2.4 per cent of the females are scrubs and, of course, the males are of pure blood, as that is the basis on which the farms are listed.

The poultry flocks owned by these farmers are particularly well bred, only 1.3 per cent of the female birds being listed as scrubs. More than 68 per cent of a total of 610,000 birds are entered on the list as standard bred. Among the herds of swine there are very few scrub sows—only 1.1 per cent. Nearly two-thirds of them are pure bred.

This Federal-State effort to improve the live stock and poultry of the country has now brought in a membership campaign that represents nearly a million head of animals and poultry. Farmers who have become members have sent in interesting accounts of their experiences in improving their animals and their bank accounts Other farmers who are taking part in the work are invited by the department to send in their individual experiences as well as those of community organizations engaged in the improvement of live stock. Definite facts and figures should be included whenever possible.—*U. S. Department of Agriculture.*

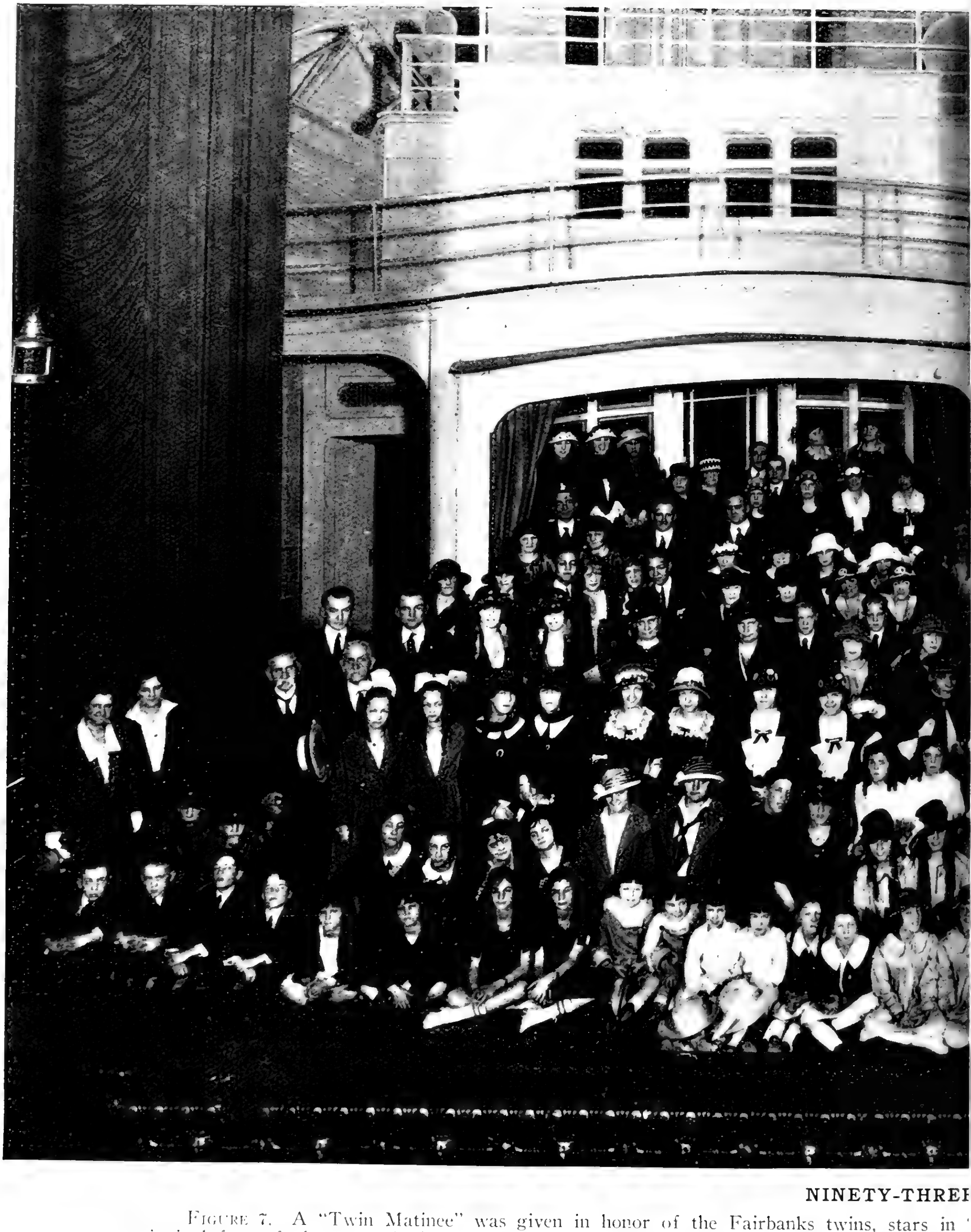
TWINS AGAIN

ALBERT EDWARD WIGGAM
New York City

IDENTICAL AND UNLIKE TWINS

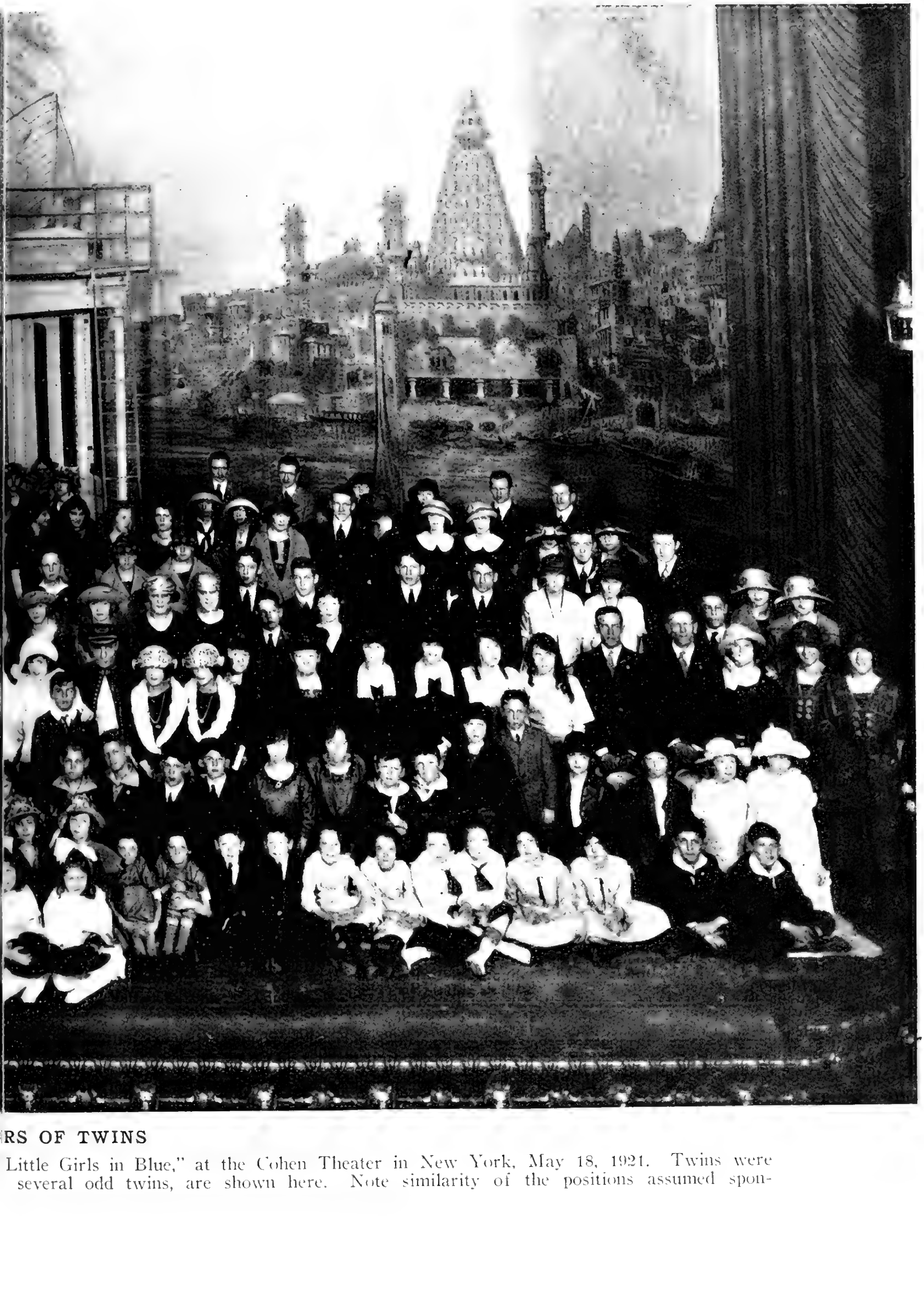
FIGURE 6. Leopold Klein and his twin brother, eighty-seven years old, have been dissimilar throughout their lives, although reared and still living under very similar conditions. The Fairbanks twins, Broadway stars, are seated between the Klein brothers. Their mental similarity is so great that they were constantly accused of copying each other's work when in school. The Austin twins (lower left) are very close duplicates, patches of freckles below their eyes being almost indistinguishable in pattern. The other girls are also identical twins, but their pose does not show their similarity so well.

TWINS are of perennial interest, both popular and scientific. The writer recently sent out a request for twins through one of the popular magazines, and received portraits of more than one hundred pairs, with numerous interesting details about many of them. While the data by themselves would not enable us to arrive at any definite conclusion, yet they are entirely in harmony with all previous studies and emphasize the fact that the nearer we approach in identity of physical organization, the nearer we seem to approach in mental traits. For instance, the writer and his wife found that by first inspecting the photographs sent in and estimating the relative resemblances in physical appearance, we could make a pretty



NINETY-THREE

FIGURE 7. A "Twin Matinee" was given in honor of the Fairbanks twins, stars in " invited free of charge, and ninety-three pairs of those who accepted the invitation, as t taneously by the identical pairs.



RS OF TWINS

Little Girls in Blue," at the Cohen Theater in New York, May 18, 1921. Twins were several odd twins, are shown here. Note similarity of the positions assumed spon-

THE FARMER TWINS

FIGURE 8. The Farmer twins are contracting masons in New York City. They state that they were born with the fingers interlocked as shown in the photograph. Possibly this has some connection with the peculiar marks in the palms of their left hands (see Figure 9). Their workmen are not able to tell which twin is directing them, and their voices can only be distinguished with difficulty. At seventy-eight their physical condition and energy is extremely similar.

close guess as to what the informants would relate in their letters as to their mental and temperamental resemblances. In reading many of the letters one could scarcely help believing he was merely reading over again Galton's letters from twins written nearly half a century ago.

Ninety-three Pairs of Twins

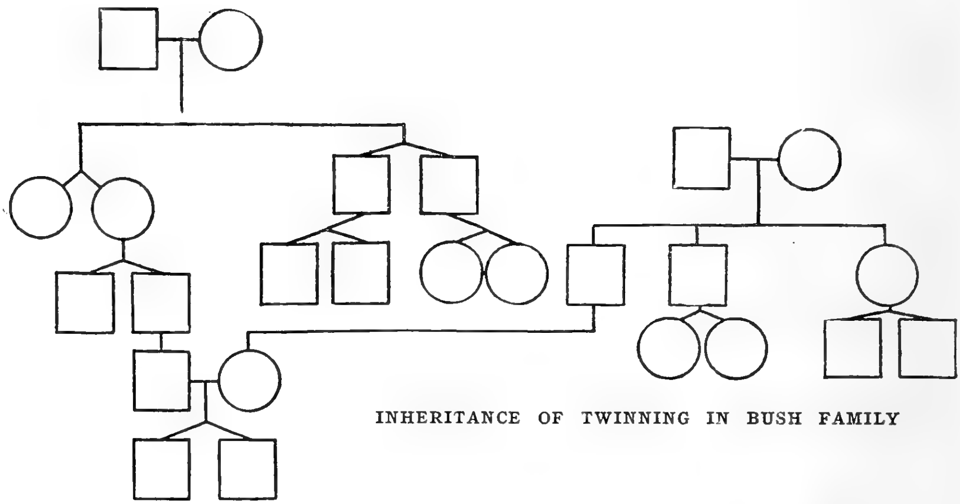
During this work a musical comedy on Broadway, "Two Little Girls in Blue," advertised a "twin matinee" in honor of the Fairbanks twins, two young ladies, stars in the play, and the Tomson twins, two young men singers of the cast, at which "all twins in New York" were invited free of charge. Such an array of duplicated human beings probably never before was assembled. The writer, a twin, sat where he could observe the audience. To see faces apparently identical, scattered in pairs all over the auditorium, moving, laughing or sitting at attention in what appeared to

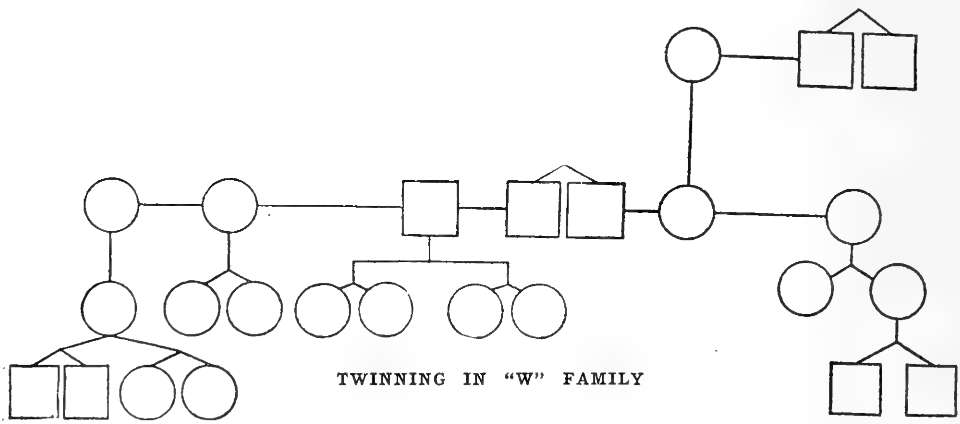
PECULIAR ABNORMALITY IN HANDS OF FARMER TWINS

FIGURE 9. This unusual "corrugation" was present at birth, and after more than half a century of handling mason's tools and rough stones these marks are still as well defined as ever, and still nearly as similar as at birth. Note the characteristic position of the little fingers, and the similarity of the lines in the palms of the hands.

be precisely the same attitudes, laughing in the same key, their faces furrowed and wrinkled in the same lines at every expression of emotion, was a unique experience. Ninety-three pairs and one or two odd ones were photographed in a group at the close of the performance. As will be noticed in the photograph, the "identical" twins are mainly disposed spontaneously in similar attitudes, while those who are plainly unlike stand or sit differently. The twins ranged in ages from seven years up to eighty-seven, the latter, the Klein brothers, unlike twins, of Brooklyn, receiving a gold medal as the oldest twins present. They informed the writer that they had always lived very much together but "were not much like each other."

The same thing came out in this study that has appeared in all studies, especially that of the JOURNAL OF HEREDITY, that the more alike twins are, the more interest they take in each other. Over three-fourths of my correspondents were very much alike. At this twin matinee, nearly all of the pairs were of the similar type. Omaha, Nebraska, reports a "Twin Club" of fifty pairs, and Berkeley, California, a club with over one hundred pairs, and judging from the pictures sent the writer from these clubs, the same phenomena hold good in these assemblages of unique human beings, since





TWO TWIN-BEARING FAMILIES

FIGURE 10. Males are denoted by squares, females by circles. Double symbols indicate twins. The last pair of twins in the Bush family are the two boys shown in the Frontispiece. All the pairs are monosexual twins in both families, but some of the pairs in the "W" family are known not to be identical. These charts do not tell much about the manner of inheritance of twinning, but they do indicate that the character is hereditary in some families, at least.

nearly all appear to be of the similar type. Another point we found was that as they approach each other in appearance almost, not quite uniformly, they express increasing fondness for each other. It could be imagined that if, through the inbreeding and assortative mating, husbands and wives should ever become as nearly alike in make-up as some of these twins are, that the divorce courts would be forced out of business. One twin, evidently highly educated, writes of herself and her brother, "reared under exactly same environment, but we have never agreed on anything. I love school work and he hates it. He dislikes everything I am fond of, although we get along well together." Two brothers, obviously unlike in appearance, write: "One is fond of outdoor life, and the other enjoys books and indoor study." Twins seem to have their drawbacks. One mother writes, "I am getting tired of having to drop my work and go to the other

end of the town to the school building to help the superintendent decide which twin he ought to spank and in some cases to decide which one he has already spanked."

Many superstitions evidently prevail about twins. Several persons wrote to ask if marrying a twin would not cause infertility, or else defective offspring. One woman, however, wrote that she had always heard that if she married a twin she could not produce children, when as she remarks, her "first baby was a set of triplets." This good woman got more than she bargained for.

I am able to present here by photographs which I have made, some interesting details of the Farmer twins, aged seventy-eight, who were among those at the "twin matinee." Each had an unusual configuration in the palm of his left hand, the remarkable likeness of which is scarcely revealed by the photographs. They grew up as hard working boys, handling stones and rough material, and from early life have been stone masons, having followed this craft for more than sixty years—two human generations—yet these rough environmental procedures, especially applied to the palms of the hands, have not prevented an almost parallel development of these physical characters. A small mole over the lid of the left eye in each twin has persisted since birth, indicating, perhaps, the marvelous minuteness of chromosomal control in ontogeny. When placed behind a screen several persons were not at all sure that they could distinguish their voices. Their children and workmen have always gotten them confused. At seventy-eight, their physical energy, as exhibited by a long walk which the writer took with them, and their movements are probably almost as nearly identical now as when they were born.

The Tomson twins were interesting since they related that their identity had been almost complete in the judgment of some of England's noted scientists. However, during the war they went through great separate experiences. They fought in different branches of the service. Both were wounded and one was gassed and they lay in separate hospitals for many months. They related that both in their own opinion and feelings, and in the judgment of their friends, these profound experiences had worked a change in their personalities and even physical appearance, so that they are not quite so much alike as before. This accords with the suggestions of Galton, F. A. Woods and others, that very great changes in the environment, especially extreme physical illness or trying experiences, will work a change in the moral and mental behavior.

However, they are still so similar that Sir Oliver Lodge has frequently entertained them for the observation of scientific men and they stated had recently "offered them $10,000 for their heads, to help him demonstrate telepathy."

Since they would often make the same side remark simultaneously in the midst of other conversation, or recall some similar memory, or express simultaneously the same desire and would give almost identical answers to questions when in separate rooms, Sir Oliver laid this to telepathy. In this connection, the Farmer twins related that on one occasion one was in New York and the other in New Orleans. Suddenly the New York twin became very much distraught and stated to friends that his brother was in great danger and needed him badly. This anxiety continued for precisely four days, and as suddenly disappeared. Information later developed that during these four days the New Orleans twin had been on a ship in a storm on the Gulf of Mexico, in hourly danger of going down. Page Sir Oliver!

The mother of the Fairbanks twins also stated that she had always tried

UNLIKE WHEN BABIES, AND HAVE REMAINED SO

FIGURE 11. A letter from one of these twins appears on pages 319-20. They have lived together all their lives, but this has not made them grow any more alike. In fact they report that they do not have even a family resemblance now.

to have the young ladies write their school compositions in separate rooms and without mutual discussion. Nevertheless, the teachers constantly accused them of copying each other's material. On one occasion they were to write four themes on given subjects and then each was to choose a fifth theme for herself. Both the twins and their mother related that they tried to keep their fifth subject secret from the other twin and their mother put them in separate rooms to write. They were themselves considerably astonished to find on comparing their work that one had written on "A Summer Shower" and the other on "An April Shower." The mother very sensibly laid this to similarity of environment, habit and physical organization, which to the writer's mind explains Sir Oliver's telepathy insofar as it may be proved by twins.

The two following letters are of great interest since they bear upon the hereditary-environment problem. One pair of dissimilar twins was reared together and the other pair, similar twins, was reared apart. I leave these persons, evidently of good sense and education, to tell their own experiences.

Mrs. Frank Prenschoff, of Petersburg, Alaska, describing herself and her identical twin, who lives in Saskatchewan, Canada, writes:

> We are girl twins, age twenty-five years, both married. I live in Alaska, while my sister lives in Saskatchewan, Canada. Unlike most twins who are always together, and who dress and talk the same, fate

SO MUCH ALIKE THEIR MOTHER CONFUSES THEM

FIGURE 12. Twins have their disadvantages. One mother writes that she is getting tired of rushing to the other end of the town to help the school superintendent decide which twin he should spank, and in some cases which one he has already spanked. The mother of these two young ladies would be able to offer small assistance, as she has difficulty in telling her own daughters apart.

seems to have kept us apart nearly all our lives. We were not raised together and have not seen very much of each other, but for all that we have always been very fond of one another and are as alike as two peas in a pod. We look alike, act alike, talk alike, and talk is the main thing we do when together. We seem to catch each other's ideas perfectly and often both start to say the same thing at the same time.

My sister married quite young, several years before I did. We were raised under entirely different environments. Our mother and father separated when we were four years of age, and my sister was raised by a friend of my mother's people, who has no children of her own. Consequently, she was raised as an only child, while I was one of a large family of children, my mother having married again.

We had only seen each other once before my twin sister came to live with us for a year, at the age of fifteen, and we were surprised to see how much alike we were, our tastes being all but the same, in dress and manners, so that even our mother would often mistake us.

Let us contrast this letter from the Prenschoff sisters who were born alike and remained alike in spite of all changes of environment, with the following from Mrs. X and her twin, who were born *unlike* and remained *unlike*, despite all the efforts of similar environment to mold them into a common pattern.

As for our appearance, as a child I was fat, blonde and healthy. My sister was thin, blonde and much weaker. She is still thin and has to watch her health. Since

adolescence, she has become a brunette, with high color when well. She is five feet and one inch in height and weighs about one hundred. I am plump and robust, medium complexion, five feet three inches tall and weigh 130. We both have brown eyes, hers very dark, mine inclined to hazel. Her hair is massive, heavy and a bit coarse, while mine is shorter, lighter and extremely fine. We both have small hands and feet, mine unusually so, enough to rouse comment wherever I go.

We have never agreed on any subject, yet never quarreled. We used to use our fists and tear each other's hair when children. We were always inseparable chums until our school days were over. She has no aversions that I know of, while I lose all control of myself if a bee buzzes around, due to a fright in childhood, I think. We have always done well in school. I was always the pest and my sister the pet of our classes. She studied hard and I didn't, but all our marks were good and alike except for deportment. My sister's marks were especially fine in history, geography, etc., while I shone in botany, physiology, algebra, music and English. She used to have nightmare over geometry until her doctor had her drop it. Nothing ever worried me.

We lived together until 1917. We were born in Pasadena in 1894, being now twenty-seven years of age. Our father was a captain in the army. Our mother died when we were four and we were brought up by five great-aunts. At the age of ten we were taken to Massachusetts to be educated, and then came further changes for us both. An aversion was taken to me by our aunts on account of my father, whom I exactly resembled in appearance and disposition. A violent, unreasoning temper was aroused in me by this attitude, and my life while there was a stormy one. I have learned to control my temper since then, I am glad to say. My sister's deportment at home was as excellent as in school, but a tendency to selfishness and obstinacy became manifest.

After leaving high school on account of my twin's health, it was decided that we go to the Sargent School for Physical Education. It was a wonderful school and we both loved it. Her health became fine and mine remained so. While there I found that while I had the endurance for long hikes, fencing and rowing, she won out when it came to tennis, swimming, jumping and muscular strength for shot putting and the like. She could go over a wall like lightning, while her plumper twin took minutes.

We haven't even a family resemblance. My sister resembles my mother's side wholly and I my father's side wholly. No one will believe that we are twins. We grow more unlike as we grow older and marriage will, of course, bring greater changes.

Personally, I do not think that such "instances," unsupported by exact measurements, settle for us the heredity-environment problem, although they do illuminate it. In this connection, I feel that all biologists and psychologists owe a debt to Prof. Edward L. Thorndike, of Columbia, for having stated this infinite complex with a clarity and definition that probably has been nowhere equalled. If this statement were kept hung up in the laboratories of all students of the problem it would probably act as a demurrer to stating that any particular trait or character or performance is due, so many per cent to heredity and so many per cent to environment. Although the large rough outlines of the two forces can, I think, be delimited by modern methods of study. On page 2 of his "Original Nature of Man," Prof. Thorndike writes (the italics are mine):

But in another sense the most fundamental question for human education asks precisely that we assign separate shares in the causation of human behavior to man's original nature on the one hand and his environment or nurture on the other.

In this issue we negelect to take for granted the co-operating action of one of the two divisions in order *to think more successfully and conveniently* of the action of the other. Thus, we say that man is by his original nature *able* to see, but *what he sees* depends upon the environment he meets; or that original nature makes him respond to certain objects by fears which environmental training weakens; or that a child *instinctively* conveys food to his mouth with the naked hand but by habit comes to use a spoon as well; or that *native curiosity* develops by proper training into interests in the arts and sciences.

The custom of abstracting out the original nature of man in independence of any and all influences upon it is *so general and so useful* it is best to follow it throughout, *remembering, however,* that from the first moments after the fertilization of the ovum a human individual is always an *acquired nature*—that in the most original behavior discoverable, such as breathing or suckling, some outside conditions are involved and that in the most exclusively acquired

ACTRESS TWINS

FIGURE 13. The DeMar sisters' voices are indistinguishable except in singing. For professional reasons one has learned to sing contralto while the other retains her natural soprano voice. Height, weight, habits, tastes, hair and eye-color, likes and dislikes are remarkably alike.

or learned arts, such as knowledge of the square root of 256, some element of original capacity has a share.

We have recently witnessed numerous popular, largely rhetorical, tirades against mental testing on the ground that it did not measure "heredity alone" or "intelligence alone." No psychologist of whom the writer is aware has ever claimed that he had measured heredity or intelligence "alone." One writer exclaims with rhetorical flourish that he "has won his case" if he has proved that intelligence tests have not measured hereditary intelligence separate from all environmental influences. His "case" never existed. It is admitted in advance. But biologists and psychclogists have found that the assumption that they were measuring either native endowment or else environmental influences separately has enabled them "to think *more conveniently and successfully*" and the method is *"so general and useful"* that they have made great advances towards solutions of some phases of the problem and illumination of others. Despite the warnings of popular journalists who have never been inside of a laboratory, they have thought it *"best to follow it throughout,"* and will probably continue to do so, *"remembering always,"* as all sound students of the problem do, the qualifications which Prof. Thorndike cites, which are inherent in the very nature of protoplasmic movement and which in human beings rise to the point of seemingly purposive behavior.

Consequently the above data is merely cited as being in harmony and not in discord with the general trend of more exact investigations.

Many twins have written of other sets of twins among their relatives, some of which data is being perused by Dr. Charles B. Davenport, to whom the correspondence has been handed. Two pedigrees are presented herewith, made up from the statements of informants and are probably exact. They throw little light upon the method of inheritance but emphasize the notion that twinning is probably a hereditary trait in some strains of the human family.

Social Conflict and Education

(*Continued from Page* 296)

lucid and disinterested presentation procures a hearing for his program of adustment by progressive leadership.

The greatest force in effecting this ideal social organization for the common weal is, Professor Williams believes, education. Throughout the book are statements of the need and power of education to right a wrong condition. The press, labor unions, religion, are recognized as educational media supplementing schooling.

Real education is a powerful factor in progress. Education is recommended to improve such seemingly divergent conditions as those of industry and academic life. There is no greater study than man and the author's plea for a study of psychology in its social relations is well founded. The hereditarian, however, believes man in his biologic relations a greater study. Nevertheless the chapters on public education are particularly valuable; they should be of especial interest to educators and students of environment.

However difficult of achievement any ideal organization may be, we are bound to adopt Professor Wiliams' attitude that knowledge is power. Intellectual analysis is a force of progress. Let us then have presentations by such able analysts as the author. Through his writings a teacher of the world beyond the classroom, "he addresses directly the thoughtful man in whatever class he may be found. And the aim is not for his assent but to challenge thought and perhaps dissent."

F. L.

MALFORMATIONS OF COTTON PLANTS IN HAITI

A New Disease Named Smalling or Stenosis, Causing Abnormal Growth and Sterility

O. F. Cook

U. S. Department of Agriculture

A PECULIAR disorder of cotton plants was found in China in 1919, as described in the Journal of Heredity for March, 1920, under the name club-leaf, or cyrtosis. After growing normally as seedlings and into the stages of flowering and fruiting, there is an abrupt change to an abnormal habit of growth with the branching irregular, the leaves contracted and distorted, and the floral buds mostly aborting. The danger of introducing such a disease into the United States was recognized.

A similar affection of cotton, with even greater extremes of reduction of the leaves and other organs, was seen recently in the north-central part of Haiti. Several fields were visited July 27, 1923, in the vicinity of St. Michel, within a radius of about three miles. Definite indications of the disease were found in all of the fields, but with wide differences in the numbers of plants affected as well as in the nature and extent of injury of the diseased individuals.

Though most of the cotton was of the Meade variety, Lone Star, Durango, Acala and other varieties of American upland cotton were represented, as well as Sea Island cotton and the type that is considered as native Haitian cotton. In some of the fields there were many hybrids between the Meade Upland cotton and the Sea Island and also crosses of these types with the Haitian cotton. A special interest attaches to the Haitian cotton on account of its apparent immunity to the disease. The development of uniform productive strains of this cotton or of some other immune type is the obvious way of controlling the disease.

Other plantings of Meade cotton at Bon Repos, a few miles from Port-au-Prince, showed no such deformities. This district is in the plain of Cul-de-Sac, nearly at sea level, while the St. Michel district has an altitude of about 1,200 feet and represents the interior plain or plateau region of Haiti. Unlike most parts of Haiti, this interior plateau region is but little inhabited. It is a gently rolling grass-covered country, not unlike the South Texas prairies. A large cotton-growing enterprise was established at St. Michel by American capital during the war period. The presence of this disease is a factor that could not be reckoned, as there is no similar disease in the American cotton belt. Also the dominant grasses of the Haitian savannas, identified by Mrs. Agnes Chase as *Themeda arguens* and *Sporobolus indicus*, are much more refractory than the Texas prairie grasses.

Comparison with the Chinese Disease

The two disorders show very similar results in altering the behavior of the plants, and undoubtedly belong to the general group of so-called "mosaic" diseases, which in some cases are caused by leaf-hoppers. The affected plants usually are more or less deficient in chlorophyll and show different shades of color with angular spots or areas, some of lighter and some of darker green, fitted together like a mosaic. In Haiti this feature is less

A NEW DISEASE OF COTTON IN HAITI

FIGURE 14. The name smalling, or stenosis, is proposed on account of the dwarfing effect. The disease affects the growing tissues of the plants and results in great distortion and reduction of the stalks, branches, leaves and floral organs. It is like the club-leaf disease of cotton in China, but with the distortion and dwarfing symptoms more pronounced, especially in the Upland type of cotton. Since the diseased parts are sterile, the production of a crop is restricted to the normal early growth of the plants, which shows no injury from the disease. This photograph shows the ends of two diseased plants of Meade cotton, the left-hand plant with only slight injury, the right-hand plant with the internodes and petioles shortened, the leaves much reduced, and short, abortive, supernumerary branches. (Natural size.)

SEVERE CASES OF SMALLING DISEASE OF COTTON

FIGURE 15. Two diseased plants of Meade cotton at St. Michel, Haiti, showing extreme conditions of abnormal growth, with leaves and floral buds abruptly reduced to very small size. Note that the abnormal growth is definitely different in the two plants, and that both plants had produced normal stalks and leaves in the earlier stages. All of the later growth is extremely contracted, with very short internodes and excessive numbers of diminutive leaves and floral buds. Abnormal branching is a feature of this disease, notably in the right-hand plant, with many small shoots and minute rudiments of leaves, similar to "witches' brooms." (Natural size.)

prominent than in China, the marginal areas being chiefly affected and those that are intermediate between the principal veins. The marginal and intermediate areas show a paler green at first, then become red, and finally turn brownish and die.

Some of the mosaic diseases have been traced to bites of insects, which are supposed to convey organic infections or protoplasmic poisons that are able to extend like enzymes through the whole system of the plant, though the injuries become apparent only in the new growth of the plants, which is discolored and distorted. The change from the normal to the abnormal growth appears very abrupt. The leaf that subtends a fruiting branch may be quite normal, while the first leaf of the fruiting branch is definitely affected. The effects of the injury are the same in the different parts of the plant, the same abnormal characters appearing at the top of the plant and at the ends of all of the growing branches.

Whether unknown parasitic organisms are involved in such diseases, or injurious chemical compounds acting like ferments or enzymes, the effects upon the development of the plants are of much interest from the standpoint of heredity. The aberrant growth of the plants shows very clearly that the normal course of development, as determined by heredity and manifested in the normal early growth of the plants, is subject to serious and persistent derangements through some cause or causes that are still unknown. The investigation of such abnormalities may throw light on problems of heredity, in addition to the purpose of avoiding losses of crops.

The Upland type of cotton in Haiti showed a more general distortion and buckling of the leaves, with less tendency to discoloration and rolling-under of the leaf-margins, which were the special symptoms with Upland cotton in China. On badly affected plants in Haiti where the leaves were dying, they turned red along the margins and between the veins, though these symptoms did not appear with such regularity as in China. In severe cases, the reddening goes in between the veins, the tissue dies, and the margins become ragged, or the leaves may become quite deeply dissected as the tissue dies back between the veins.

The behavior of Upland cotton in Haiti is more like that of the Asiatic type of cotton in China, except that the growth of distorted leaves did not form such dense, club-shaped masses as in the Chinese cotton. The dense masses of foliage in the Chinese cotton resulted from shortening the internodes and increasing the number of branches, which also are features of the Haitian disease, but not to the same extent. On the other hand, the tendency to reduce the affected parts to very small size is carried notably farther in Haiti than in China. There were not in China such extreme cases of reduction of leaves and flower buds as shown in Figure 16.

The symptoms of the disease in Haiti did not seem to be modified by the conditions in the same way or to the same extent as in China. Though some plantings seemed to be more seriously and more regularly deformed, like the field planted to Lone Star, cases of extreme deformity and dwarfing also occurred among the normal, uninjured plants. This is consistent with the other fact of a wider range of diversity in the nature and extent of distortion and dwarfing of growth in Haiti. As with the Chinese disease, the Sea Island type of cotton showed less dwarfing and distortion than the Upland type. One variety of Indian cotton with very hairy leaves seemed to be immune to the Chinese disease, while the so-called "native" cotton in Haiti seems not to be affected by the smalling disease.

Analogy of Gall Formation

That there are substances which have a specific action in changing the course of normal development and producing abnormal growth, is shown by the familiar phenomena of gall-formation. Since the same plant may pro-

duce different kinds of galls, in response to the injuries of different insects, there can be little doubt of the specific effects of the insect secretions in producing malformations of the growing parts of plants.

The distortions produced by the mosaic diseases may be thought of as relatively slight and generalized gall-formations, or as analogous to the so-called "witches' brooms." These analogies would apply whether the poisonous substances are supposed to come directly from the insects, or to come from bacteria or other parasitic organisms conveyed by the insects and able to live in the cells and alter the habits of growth, as in the case of the crown-gall bacteria investigated by Dr. Erwin F. Smith. But instead of the definite reactions seen in the formation of galls, or in the abnormal branching that results in "witches' brooms," these mosaic diseases have more generalized effects through unbalancing of heredity. It is conceivable that the secretions of a parasite, or other poisonous substance, might disturb the normal relations of development in the same way that the placing of plants in a new environment sometimes calls forth a large amount of variation. Results recently reported by Mavor and Svenson of experiments with fruit flies, show that exposure to X-rays increased the number of cross-overs, or hybrid combinations of character by reducing the normal tendency of characters derived from the same parent to cohere or remain associated in the hybrid progeny.*

Varied Proportions of Diseased Plants

Assuming that the Haitian disease is of the same general nature as that of China, the varied proportions of affected plants in the different fields in Haiti is a feature of interest as throwing light on the nature of the disease. Such evidence was not obtainable in China, because all of the plants were affected. The difference may be explained by the great abundance of leaf-hoppers in the Chinese fields, whereas leaf-hoppers were not noticed in Haiti. Specimens of the Chinese leaf-hoppers have been identified by Mr. W. L. McAtee as species of Empoasca and Eupteryx.

Many different forms and degrees of distortion were observed among the individual plants in China, as in Haiti, but in the central districts of China that were visited the club-leaf disease appeared universal. At least it was so generally established in the fields by the end of the season, that all of the late growth was more or less abnormal. Contrasts were afforded between the normal early growth and the distorted late growth, but there were no normal plants to compare with those that had suffered injury and distortion, so that in China the idea of an external environmental cause of the injuries could not be so definitely excluded.

Only one of the fields in Haiti, planted to the Lone Star variety, had all of the plants affected. The distortion of the later growth in most cases was great, and no individual was found that was producing new normal growth. The early growth had been normal for a sufficient period to allow many normal bolls to develop, though not attaining the full size of the variety as it grows in Texas. One large plant was noted that apparently had escaped injury much longer than the others and had produced larger and more numerous bolls, but even in this plant the new growth was distinctly distorted.

Most of the fields at St. Michel were of the Meade cotton, in some places with the disease nearly as bad as in the Lone Star field, in other places with normal and abnormal plants mixed in varied proportions. Some of the fields were affected to only a slight extent, with the distorted plants appearing as scattered individuals, estimated at five per cent or less of the plant population. Only a few rods away the proportion of injured plants might be much higher, showing that the agents of infesta-

*Science, August 17, 1923, page 124.

tion had been more numerous or more active in some parts of the fields than in others.

It seemed very remarkable to see badly crippled and dwarfed individuals with plants on either side two or three times as tall, of normal stature and leaf formation, even to the top growth. It was plain that injury or infection of the crippled individuals must have occurred at a rather definite stage of development, and that the insects or other agents of infection had been few in number and had worked in the fields for only a short time, or some of the plants would show later injury. The injured individuals showed that the disease had been present for many weeks, and the absence of late infestations could only be taken to mean that the agents for communicating the disease could not have continued their work in such fields, unless it be assumed that the plants are susceptible at a certain age or under some special, temporary condition.

Varied Forms of Distortion

The Haitian disease, like that of China, is not manifested by a definite form of injury to the plants, but results in various kinds and degrees of malformation, showing that the normal heredity or course of development of the plants is profoundly disturbed. Try to imagine a human disease that could turn all the children of a city or a section of country into cripples, with the different parts of the body distorted in various ways, or sometimes lacking altogether. In such a population the preservation of normal heredity would be an acute problem. Not only are questions of resistance or immunity involved in the study of such a disease, but the marked deviations from normal heredity are of interest as showing how the "mechanism of heredity" may be deranged.

The nature and extent of the deformities may be judged from the photographs and explanations that are given in the legends. Figure 14 shows a plant that was only slightly distorted and another that represents a rather frequent type of more severe injury, neither of these plants producing floral buds. More severe crippling is shown in the two plants of Figure 15, one with the leaves and flower-buds reduced to very small size, and the other an extreme case of dwarfing, with the internodes extremely short. This plant had grown only about four inches after it became affected, the leaves and flower-buds being reduced nearly to microscopic size. Earlier in the season both of these plants had produced leaves of normal size and shape, showing that they were not natural or congenital dwarfs, but changed suddenly into the crippled state after a period of normal development.

Perhaps the most characteristic feature of the disease, as showing that it is different from the Chinese disorder, is the development by many of the affected plants of large numbers of small flower-buds. Some of these may be restricted to very small size as on the plants shown in Figure 15, but not infrequently the development continues to the flowering stage, some of the plants producing large numbers of under-sized flowers from the dwarf buds, as in Figure 16. In such cases abortion usually takes place soon after flowering, but small distorted bolls are retained by some plants.

As in the Chinese disorder, some of the badly crippled plants have the leaves crumpled or buckled and with irregularly torn or eroded margins, and some plants have leaves with irregular perforations or scars of partially united tissue, very similar to the tomosis or leaf-cut disease of young cotton in the United States, but apparently continuing for the life of the plant in these abnormal individuals. Such a plant is shown in Figure 16, with several of the leaves taken separately after boiling, to restore the natural turgidity and configuration.

The reason for considering these widely different abnormalities as symptoms of the same disease is that the diversity is so general and that there

seems to be no break in the series that would require the assumption that two or more diseases are involved. Many of the abnormal plants probably could not be distinguished from extreme cases of degenerate "rogues" or perjugate hybrids, and these factors of diversity were present also in the mixed fields. But the disease injuries were equally severe in the more uniform unmixed stocks, grown from newly imported seed.

It may not appear reasonable to suppose that so much diversity arises directly from one cause, unless it is considered that the diversity is in the plants rather than in the disease, so that the disease is considered as a disturbing factor rather than as a definitely directive agency, such as the insect secretions that produce galls. This distinction makes it possible to think of the disease as disturbing the growth of the new tissues, without affecting the tissues already formed. In some of the mosaic diseases where seed has been grown from affected plants the seedlings proved to be normal, which would indicate that the germ plasm is not affected, but only the growth processes.

The Disease Not Contagious but Infectious

It was plain that the disease was not contagious in the ordinary sense, but required some active agent of transmission that had been present temporarily, and had later disappeared. Later infections must have occurred, if insect conveyors of the disease had continued to work in the fields after some of the plants became affected. Such evidences of spread of infection were looked for in places where the injured plants were few, but the uninjured plants remained normal to the top, while adjacent individuals had been crippled from an early stage of growth, when the stalk was only six to eight inches high.

That only a few plants were injured in some places may be due to small numbers of insects that were present, or to the sources of infection being scarce or remote. The occurrence of such a disease, and the extent of injury might vary greatly with the seasons, depending upon the abundance of insects or upon the existence of the disease in a native host-plant of the insects. Hence it would seem desirable to study the native cotton and related plants as having possible relations to the occurrence of the disease. Since the period of insect activity may be short, the season of planting might largely determine the amount of injury. Earlier planting might secure more growth in advance of the disease, while plantings made late enough might escape entirely.

The only disease or disorder of cotton thus far recognized in the United States as possibly analogous to the Chinese and Haitian diseases is one that has attracted attention for the last two or three seasons in the Salt River Valley of Arizona. The popular name "crazy-top" is being applied by the farmers, on account of the abnormal branching and sterility of the upper part of the plant. The abrupt change from the normal growth and branching of the lower part of the plant is a feature of similarity with the mosaic diseases.

Sterility and abnormal branching habits are the more notable features of the disease in the Pima or Egyptian type of cotton, but in the Upland varieties that are now being planted in the Salt River Valley there are more pronounced symptoms of reduction, crumpling and crowding of the leaves, which may represent the same disorder. The branching of such plants is distinctly abnormal, with many axillary shoots, decurrent stipules, or fasciations. The floral buds and bracts also have a very restricted development, so that few bolls are produced, and these usually are very small.

The occurrence of the "crazy-top" injury is also very erratic, with no apparent relation to cultural conditions. The injured plants may be sprinkled indiscriminately among normal individuals, or in some places a majority

SMALLING DISEASE WITH REDUCED INVOLUCRES AND FLOWERS

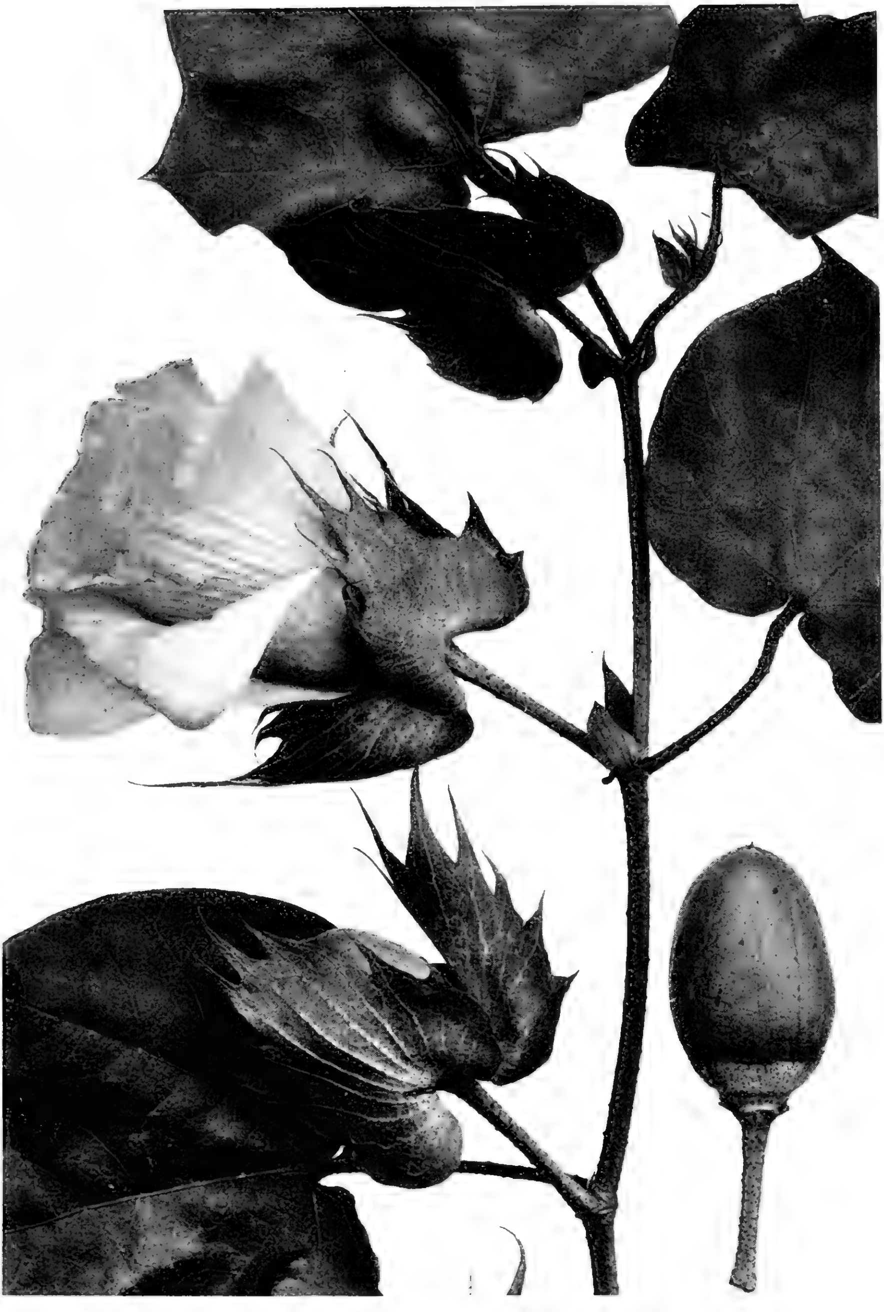
FIGURE 16. The distortion is less extreme than in Figure 15 and the buds develop to the stage of flowering, but the leaves, bracts and flowers are notably reduced, with the involucres restricted to small size and the petals often very short, as in the lower flower. The leaves are narrowed and deeply lobed, with the surfaces and margins uneven. Note the contrast in leaf-forms with Figure 17, and also with Figures 14 and 15, as showing the wide range of diversity in the abnormal growth induced by the smalling disease. (Natural size.)

SMALLING COTTON DISEASE WITH CRUMPLED LEAVES

FIGURE 17. Sterile growth of a Meade cotton plant, with short-lobed, crumped leaves. Many of the leaves had deeply eroded margins and irregular perforations, partly healed or regenerated, as in the leafcut or tomosis disorder which is common in the United States. Usually tomosis is confined to the seedling stage of normal plants, but sometimes continues throughout the life of degenerate hybrids or "rogues." Such mutilations of the leaves are caused by the death of small areas of the leaf tissue at very early stages. The oil-glands die first, in advance of the neighboring cells. (Natural size.)

PLANTS OF THE BOURBON COTTON IN HAITI

FIGURE 18. The "Native Haitian" or Bourbon cotton (*Gossypium purpurascens*), which showed no symptoms of the smalling disease. This species is very common in Haiti, both cultivated and half wild, in waste places, and furnishes most of the cotton that is exported. It is a perennial shrub, often attaining ten to twelve feet in height. The general appearance of the foliage is not unlike American Upland cotton but the Upland varieties from the United States usually grow three or four feet tall in Haiti. The fiber is like Upland cotton, with staple from an inch to an inch and a quarter. Photographed by C. B. Doyle, at Gonaives, Haiti, September 7, 1917.



DETAILS OF THE HAITIAN COTTON

FIGURE 19. A fruiting-branch of the native Haitian or Bourbon cotton, with floral buds or "squares," a flower, a young boll, and a mature boll, in natural size. The boll is more rounded at the tip than usual, most of the bolls having a distinct short point. The petals are yellow with a purple spot at the base, as in Sea Island cotton, but the leaves and the bracts of the involucre are most like Upland cotton. The bracts commonly are united at the base as in Egyptian cotton. Since this type of cotton apparently is immune to the smalling disease, it may be better suited to cultivation in Haiti than the American Upland type, so that the breeding of uniform and productive varieties of Bourbon cotton would be a means of avoiding injury from the smalling disease.

of the plants show the "crazy-top" injury, with occasional individuals that remain normal. Thus the mode of occurrence may indicate an insect-borne disease of the mosaic class, but with the external symptoms much less striking than in the Chinese and Haitian diseases.

No Indication of Recovery

With this indication that the cause of the injury had disappeared from such areas, greater significance may be ascribed to the fact that the injured individuals continued to grow abnormally instead of recovering as would be expected if the disease were of the temporary nature of plant-louse injury which ceases to affect the plants as soon as the cause is removed. In India and also in Nyasaland, according to Mr. H. C. Sampson, there is a temporary disorder of cotton leaves due to attacks of Jassidae, which may seriously cripple the plants during the rainy season, but after the insects disappear, in the dry season, the plants recover and resume their normal habits of growth. With the Chinese cotton disease all of the plants were affected, and no indications of recovery were noted. In some cases the later growth appeared less distorted, but this was considered as a result of more moderate conditions in the latter part of the season, the amount of distortion being determined to a considerable extent upon the conditions, though the presence of the disease is still apparent in plants that grow with the least distortion.

In this respect the Haitian and the Chinese diseases may be contrasted. Not only is there a wider range of degrees and forms of distortion in the Haitian disease, but there seems also to be less relation to the external conditions. Some of the extreme cases of crippling like that shown in Figure 16 were found in places where the uninjured plants showed that conditions had been very favorable for normal growth.

Immunity of the Haitian Cotton

The so-called native cotton may be of interest in two ways in relation to the disease. The fact that the disease apparently does not injure this type of cotton does not prove that the infection might not come from the immune cotton. The insects that cause the disease might feed on the native cotton, or even make it their regular home. This would be the more possible because the native cotton is a large perennial bushy plant, often growing to a height of eight or ten feet, with woody stalks often two inches or more in diameter at the base. It is generally distributed about the towns as well as in the rural districts of Haiti, either as a dooryard plant or growing half wild in neglected grounds or waste places.

Of course, it is possible that a closer study might detect a slight injury of the native cotton, but most of the plants appeared to be quite uninjured. A few cases of plant-louse distortion were observed in the Haitian cotton. Red spiders and black-arm were prevalent and appeared also on the Haitian cotton, with occasional plants showing distinct susceptibility. One plant afforded a rather striking example of the "rust" caused by red spider, with the leaves discolored and distorted over half the surface while on adjacent plants the red-spider injury was confined to small yellowish spots between the bases of the principal veins.

A notable diversity in form, color and hairiness of the leaves may be ascribed to crossing with Sea Island or Upland types. Several forms of Sea Island cotton have been observed in Haiti, and are widely scattered, but in no such abundance as the Bourbon cotton.

A planting of the Lewis variety of Upland cotton from North Carolina was seen on La Gonave Island September 17, 1917, and in the same garden a tall, upright, purple "native" cotton. The foliage of the Lewis cotton was very pale green, with the leaves and stems distorted, and the branches very

short-jointed. The leaf surfaces were uneven and buckled, with the color varied from a finely mottled pale yellowish green to much deeper green in bands along the veins. Many of the involucres were abortive, consisting of a single bract. The possibility of a physiological, chlorosis disease, due to excess of lime, was suggested by the very pale color, but the purple "native" cotton had normal dark foliage. Another form of mosaic disease may be indicated, with less reduction and distortion, but the color reactions much more pronounced.

Haitian Cotton Not Related to Sea Island Cotton

Visitors from the United States often suppose that the Haitian cotton belongs to the Sea Island type because the plants grow tall and the flowers are golden yellow, with purple spots at the base of the petals. Also the seeds are smaller and generally less fuzzy than in American Upland cotton. But those who are familiar with Sea Island cotton will see at once that the leaves of the Haitian cotton are entirely different, being relatively broad and short, and usually with three lobes instead of the five lobes of well developed leaves of Sea Island cotton. Also the lobes are short and rather divergent, not separated by deep cuts nor with the lobes partially folded, to render the upper side of the leaves deeply channeled. Thus with respect to the leaves the Haitian cotton appears much more similar to the Upland type, especially the plants that are somewhat hairy. Also the bolls are of a light green color, more like those of Upland cotton.

In reality the resemblance of the Haitian cotton to our American types is entirely superficial. No such cotton has been found in other parts of America that have been explored, in the continental regions. The Haitian cotton is not really a native species, but probably was brought from the East Indies during the period of the French occupation. It undoubtedly belongs to the species that is known botanically as *Gossypium purpurascens*, and usually is called Bourbon cotton, from the Island of Bourbon, now generally known as Reunion, east of Madagascar in the Indian Ocean, whence it is supposed to have been carried by French colonists to different parts of the world.

The salient characteristics of this type of cotton are the tall growth and perennial habit, the purple color of the stalks, branches and petioles, with prominent black oil-glands, the broad, short leaves mostly with three short, divergent lobes, the short calyx, the large yellow, purple-spotted flowers, the rather small oblong-elliptic bolls, more or less apiculate, and the small, slightly fuzzy seeds.

Though apparently not cultivated in any of the more important producing countries, the Bourbon cotton has been widely distributed in the tropical regions, especially in the Old World. It is grown to a slight extent in India and, according to Mr. Sampson, is there considered immune to the attacks of the insects that in other types of cotton cause a serious distortion of the leaves, as already stated. But the insect injuries in India apparently are not the same as those in Haiti, since the cotton in India is said to recover completely in the dry season after the Jassidae disappear, whereas in Haiti the disease apparently continues in unabated form long after the agents of infection have ceased their work.

Where recovery is possible, as in the distortion caused by plant lice, the theory of permanent infection by a parasitic organism would seem less applicable, so that two classes of diseases might be distinguished, as recoverable or as permanently infected. Abnormal behavior or diseased conditions of cotton have been described from the Virgin Islands and elsewhere in the West Indies, but without definite indications of the smalling disease.

HEREDITY AND EUGENICS

A Review

Grundriss der Menschlichen Erblichkeitslehre und Rassen Hygiene. Vol. I, Menschliche Erblichkeitslehre, by Dr. Erwin Bauer, Dr. Eugen Fischer and Dr. Fritz Lenz, pp. 442; Vol. II, Menschliche Auslese und Rassenhygiene, by Dr. Fritz Lenz, pp. 364, 2nd ed. Price of Vol. 1 in paper, $2.25; cloth, $2.50; Vol. II, in paper, $1.75; cloth, $2.00. J. F. Lehmann's Verlag, Munich, 1923.

Little more than a year has elapsed since the first edition of this encyclopedic work appeared, and now a second edition is at hand, enlarged and improved. Professor Baur (who deals with genetics) and Professor Fischer (who treats of anthropology) have made little change in their contributions, but Professor Lenz, who is responsible for the greater part of the work, has added a hundred pages of new material to each volume. The work is, of course, open to many minor criticisms, but on the whole it is worthy of the best traditions of German scholarship, and is to be warmly recommended to all who seek a comprehensive picture of the science of eugenics as it is understood in Germany (where, by the way, it has received much attention since the war). Practical measures by which eugenics might be furthered are discussed by Dr. Lenz specifically under sixteen heads, an enumeration of which will give a fair idea of the trend of his thought:

1. Combatting "racial poisons," such as alcohol.
2. Combatting venereal diseases.
3. Methods for cutting off defective lines of descent (segregation of the feebleminded and others).
3. Prevention of the marriage of the unfit.
5. Measures (such as a form of insurance) that may help superior parents to have more children.
6. Pay and occupation in their relation to eugenics.
7. Taxation.
8. Inheritance laws.
9. Rural colonization ("back to the farm"), a measure to which the author attaches much importance.
10. Direction of German emigration, which should be toward Russia and Siberia, the author thinks.
11. Social reforms involving a happy medium between state socialism and a capitalistic regime.
12. Changes in the educational system.
13. Research and propaganda in eugenics.
14. Health and eugenic surveys of the population.
15. Direction of the medical profession toward preventive medicine.
16. Protection of the Nordic race.

A final section of sixty pages on "personal eugenics" tells the individual what he or she can do to live eugenically. A glossary and bibliography complete the work.

P. P.

The

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CONTENTS

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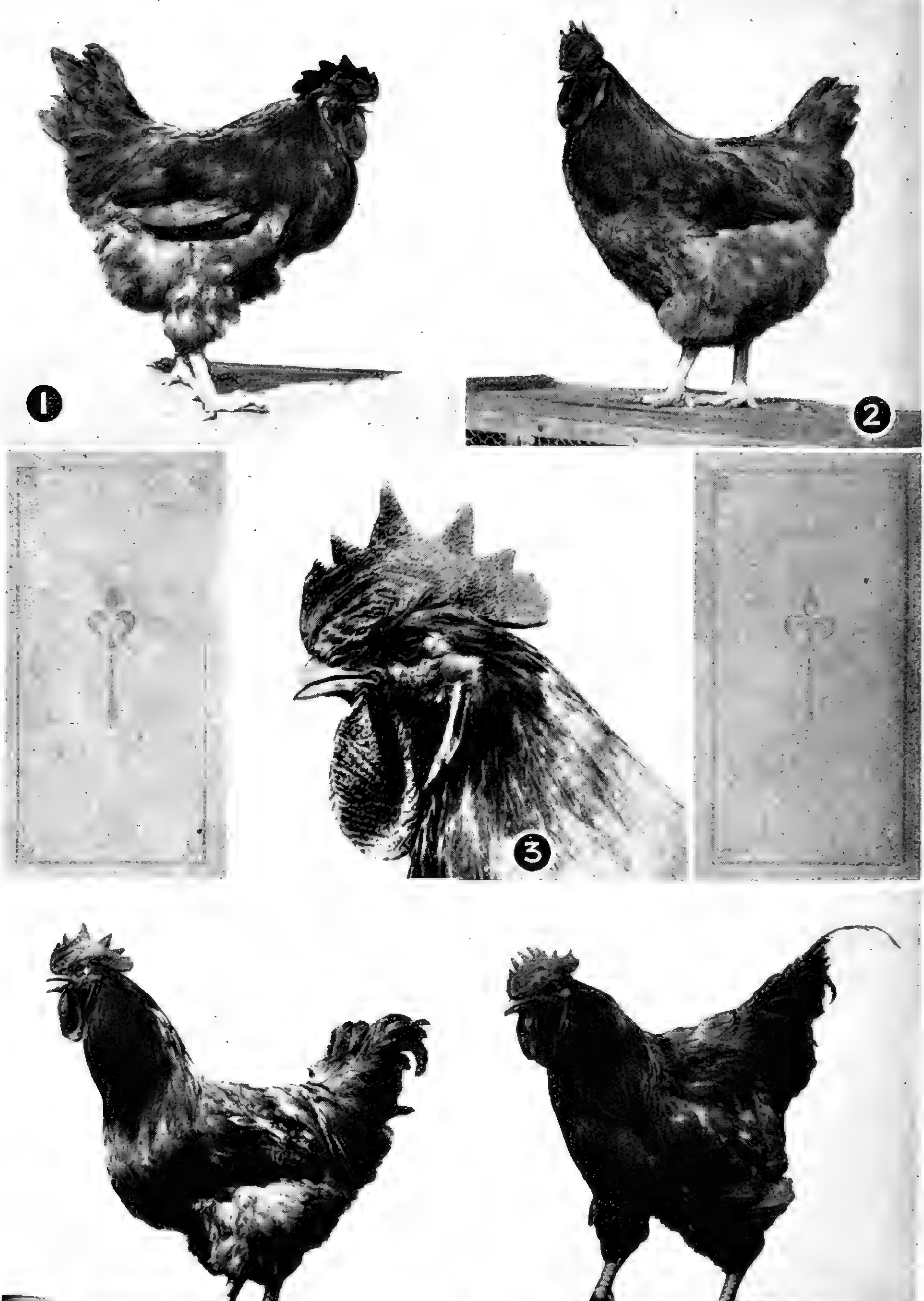


THE HEN THAT BECAME A ROOSTER

Four views of a hen that underwent complete sex-transformation, and one of her sons (No. 5), hatched in March, 1920, when she was functioning as a female. The photographs were taken at intervals as the change in sex was taking place: 1. On March 17, 1921; 2. On May 20 of the same year; 3. and 4. On February 24, 1922. Then, on July 7, 1922, two chicks were hatched, of which this "hen" was the sire. (Frontispiece.)

[See **Complete Sex-Transformation in the Domestic Fowl,** by F. A. E. Crew. Page 361.]

MENDELIAN ANALYSIS OF THE PURE BREEDS OF LIVESTOCK

I. The Measurement of Inbreeding and Relationship

SEWALL WRIGHT

Bureau of Animal Industry, United States Department of Agriculture, Washington, D. C.

THE pure breeds of livestock which we have today are the result of many years of patient effort. It seems likely that they will furnish the material for further improvement for many years to come. It should thus be of value to study the methods used in their development and attempt to express in terms of modern genetics what these methods should have accomplished, and what, in consequence, is the present genetic status of the breeds. Before dealing directly with the work of certain of the leading breeders it will be well to consider briefly the successive phases in the history of livestock breeding, the light which discoveries in genetics has thrown on the earlier breeding methods, and finally, the analytic methods by which the data in livestock pedigrees can be related to Mendelian theory.

Successive Phases in Livestock Breeding

Livestock breeders did not have to wait for the development of a science of breeding to accomplish a great deal in the improvement of livestock. From the first, indeed, there must have been modification of the wild types through the retention of those animals which were most tractable, and it was merely necessary for the early shepherds and herdsmen to come to a realization of the great fact of heredity, for the conscious molding of animal forms and function toward greater usefulness to man to commence.

Primitive man naturally made no distinction between innate differences between animals and those due to differences in care and feeding, and believing that all were equally transmissible, concluded that good care and liberal feeding were short cuts to livestock improvement. Numerous other beliefs, partially true or wholly false, such as those concerning the injurious effects of matings between close relatives, the effect of maternal impressions, telegony, and so forth, contributed to the traditional lore of breeding. The realization of the fact of heredity, aided indirectly by some of the other beliefs, was undoubtedly enough to lead to a very considerable improvement.

Intensive efforts toward the improvement of local types of cattle and sheep began in England early in the eighteenth century. After the leaders in this movement had reached a certain degree of success, they began to find difficulty in securing animals from other herds and flocks which did not have a detrimental influence. They began cautiously to breed within their own stocks. Such experiments were conducted most boldly by Robert Bakewell,[1]* who discovered that he could practice close and continued inbreeding not only without necessarily causing degeneration of his stock, but with a rapid fixation of the types for which he was selecting. Those seeing his Longhorn cattle and Leicester sheep could not but see the difference between them and the stock of his neighbors. Their uniformity of type brought

*For numbered references, see *Literature Cited* at end of article.

clearly to the eye their features of superiority.

Bakewell's example was followed with enthusiasm by other breeders and closely bred strains of the best local types of animals began to appear in all parts of England. The Colling brothers began following this system with the shorthorned cattle of the north of England. Their work was carried on by other breeders, notably by Thomas Booth and his descendants and by Thomas Bates, with whose methods we are to deal in a succeeding paper.

While many of these early breeders had notable success with close breeding, injurious effects seem to have been encountered with such increasing frequency in later years as to discourage the practice. The superior types which had been developed in each region, were, however, maintained and developed into the pure breeds as we know them. Herd and flock books were established for the recording of pedigrees. Efforts at improvement took the form of selection within these pure breeds and in the grading up of common stock by the continued use of purebred sires. This is essentially the status of the art of livestock breeding today.

During the last quarter of a century a real science of breeding has been developing about the principles of heredity discovered by Mendel. Mendelian heredity has been found to be the regular mode of inheritance for all sorts of characters and in all sorts of organisms. We have come to believe that it is the general law of heredity under sexual reproduction.

With accurate knowledge of the principles of heredity, the hereditary characteristics of many plants and of the small and rapidly breeding laboratory animals can be controlled with something of the precision of the chemist working with non-living materials. Livestock breed relatively slowly, however, and the large generations obtainable from laboratory animals are not feasible. Genetic analysis must thus be slow. Nevertheless, genetics has an important contribution to practical breeding in the insight which it gives into the results of the long-known mass methods of breeding: assortative and disassortative mating, selection and culling, inbreeding and outcrossing. This is particularly true in the case of inbreeding and outcrossing.

The Effects of Inbreeding and Crossbreeding

The principal effect of inbreeding, we find, is in automatically making homozygous some combination of the factors which were heterozygous in the original random-bred stock. Immediately related to this is the increase in uniformity in an inbred stock, which makes it possible to recognize genetic differences which would otherwise be overlooked. Increased prepotency in outside crosses is another direct consequence of increase in homozygosis. A usual but not necessary decline in vigor in all respects is explained as due to a tendency for recessive factors, brought to light by increased homozygosis, to be more frequently deleterious than dominant factors. This tendency in turn is explained as due merely to the greater rapidity with which natural selection can eliminate the deleterious dominant variations that arise in a random-bred stock. These conclusions and their interpretations have been tested with diverse kinds of plants and animals. Among mammals, Miss King's experiments[2] at the Wistar Institute with inbreeding and selection in a line of rats have shown clearly that inbreeding does not necessarily lead to deterioration. The experiments of the Bureau of Animal Industry[3] with twenty-three different inbred lines of guinea pigs have also demonstrated that even twenty-five generations of brother-sister mating may not cause any obvious degeneration. They have, however, demonstrated that some decline with inbreeding is the usual result in such characters as weight, fertility and vitality. They have also brought out a conspicuous differentiation among

different inbred lines in characters of the above kinds in which it has been almost impossible to demonstrate heredity otherwise. Another result has been the recovery of full vigor on crossing different inbred lines, explained as due to the complementary nature of these lines, each in general, supplying the particular dominant factors for vigor which had been lost in the other.

Characteristics differ greatly in the extent to which they are determined by heredity. Some, like most coat colors, are almost wholly hereditary. Others, like fertility and length of life are largely environmental as far as the individual is concerned. Inbreeding is as effective in making homozygous such heredity as there is in the latter case as in the former. Selection, on the other hand, is effective only in proportion to the importance of the hereditary element. The number of independent factors which effect the character also play a part in determining the effectiveness of selection methods. With knowledge of the effects to be expected theoretically from the various methods of breeding, in dealing with characters determined to any given extent by heredity, and showing any degree of segregation in the second hybrid generation as compared with the first generation, and showing any degree of dominance, it should become possible to lay plans on a sound basis for the best system of mating to follow to obtain the results which are desired with any particular character.

The application of even these methods to livestock improvement must necessarily, however, be a rather slow and expensive process. Meanwhile it is important to check them as far as possible by study of the methods actually used by those breeders who have been recognized as having been most successful and find out in terms of modern genetics just what it was that they did.

Importance of Skill in Judging

That the breeders who laid the foundations for the pure breeds were exceptional among their contemporaries as judges of livestock and thus exceptionally skillful in making matings between animals which were really superior, we may take for granted as a big element in their success. The importance which Thomas Bates attributed to his ability in this direction may be inferred from a quotation from a letter, "A hundred men may be found to make a Prime Minister to one fit to judge of the real merits of Shorthorns." We can form some idea of the ideals which these men strove for from the descriptions and pictures of the noted animals which they bred. Recognizing the importance of their ability as judges, it is nevertheless difficult to put a quantitative measure on what they accomplished by selection.

Measurement of Inbreeding

We can, however, discover by study of pedigrees how far they practiced inbreeding and how far they maintained a general resemblance to particular worthy animals by concentrating their blood. We need to use measures of inbreeding and relationship which shall make it possible to relate the methods of these breeders directly to the modern theory of genetics. Such coefficients have been described in a previous paper.[4]

The coefficient of inbreeding (F) depends primarily on the number and closeness of the ancestral connections between the sire and dam and secondarily on the degree of inbreeding of the common ancestors of the latter. Every chain of generations in the pedigree by which one may trace back from the sire to a common ancestor and then forward to the dam, passing through no animal more than once (within the given chain), contributes to the inbreeding an amount equal to one-half used as a factor one more time than there are generations in the

chain, with the qualification that this must be multiplied by a corrective term $(1 + F_A)$, in case the common ancestor (A) is himself inbred.*

It was demonstrated that this coefficient measures accurately the percentage departure from the number of homozygous factors in the random-bred stock toward complete homozygosis. If there were for example, 60 per cent homozygosis in the random-bred ancestral stock, a coefficient of inbreeding of 50 per cent means that the individual in question should be homozygous in 80 per cent of his factors.

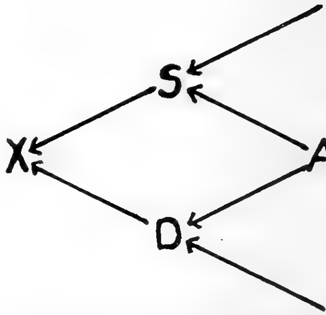
The method of calculation may be made clearer by a few examples. Let us take first the simple case in which a mating is made between half brother and sister (Figure 1a). The sire and dam are connected in only one way. There are two generations in the connecting chain, *S-A-D*. As the common ancestor (A) is not himself inbred, the formula is simply $(\frac{1}{2})^3$. The coefficient of inbreeding is thus 12.5 per cent.

If the sire is a grandson and the dam a daughter of the common ancestor (Figure 1b), there are three generations between sire and dam and the coefficient is $(\frac{1}{2})^4$, or 6.25 per cent.

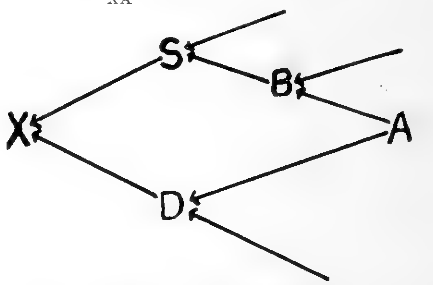
If now the mating is between full brother and sister (Figure 1c), the lattter are connected by two chains, each containing two generations. The formula requires us to find the sum of the contributions of each chain. We have then $(\frac{1}{2})^3 + (\frac{1}{2})^3 = \frac{1}{4}$ or 25 per cent as the coefficient of inbreeding. With two generations of brother-sister mating (Figure 2a), the reader will readily see that sire and dam are connected

*Letting F_X and F_A be coefficients for the individual and for a representative common ancester of his sire and dam, and letting n and n' be the number of generations between the sire and dam respectively and their common ancester, we have as the general formula:

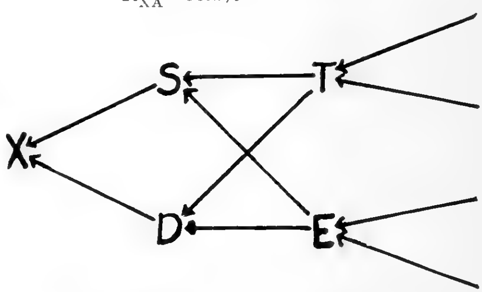
$$F_X = \Sigma_A\left[\left(\tfrac{1}{2}\right)^{n+n'+1}(1+F_A)\right]$$



(a) A mating of half brother and sister
F_X=12.5%, R_{SD}=25%,
R_{XA}=47.1%



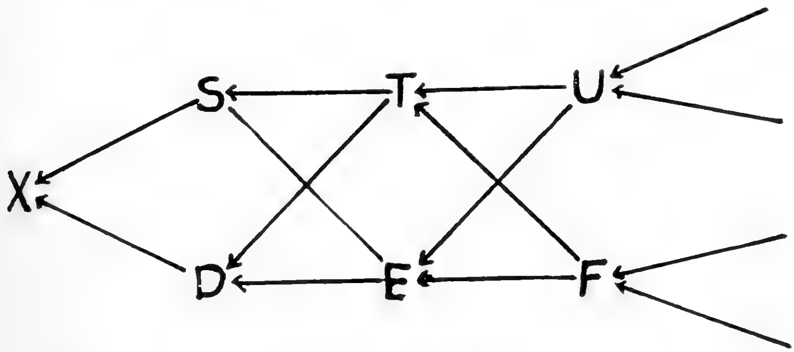
(b) A mating between grandson and daughter
F_X=6.25%, R_{SD}=12.5%,
R_{XA}=36.4%



(c) A mating between full brother and sister
F_X=25%, R_{SD}=50%,
R_{XT}=44.7%

INBREEDING AND RELATIONSHIP

FIGURE 1. The chart shows three cases of inbreeding: mating of half brother and sister, mating between grandson and daughter, and mating of full brother and sister. The coefficient of inbreeding (F_X) of the resulting individual is given, in each case, also the coefficient of relationship between his sire and dam (R_{SD}), and between X and the ancestor to whom the inbreeding is due (R_{XA}). A coefficient of relationship of 50 per cent represents that existing between ordinary brothers and sisters.

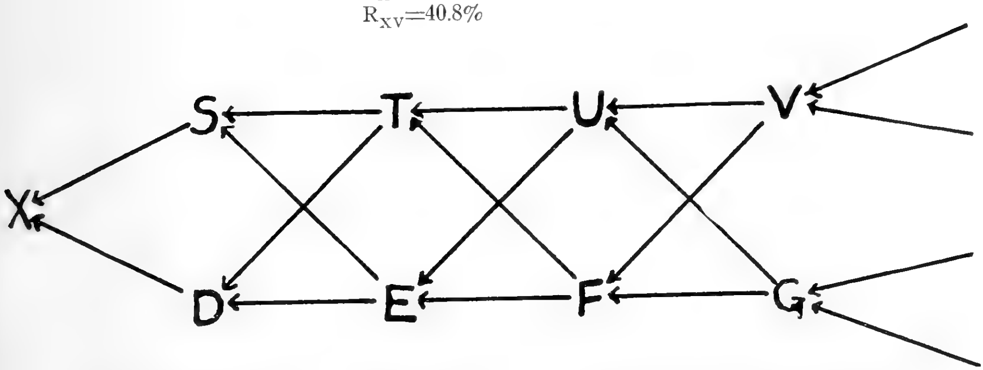


(a) Two generations of brother-sister mating

$F_X = 37.5\%$, $R_{SD} = 60\%$,
$R_{XU} = 42.7\%$

(b) Three generations of brother-sister mating

$F_X = 50\%$, $R_{SD} = 72.7\%$,
$R_{XV} = 40.8\%$

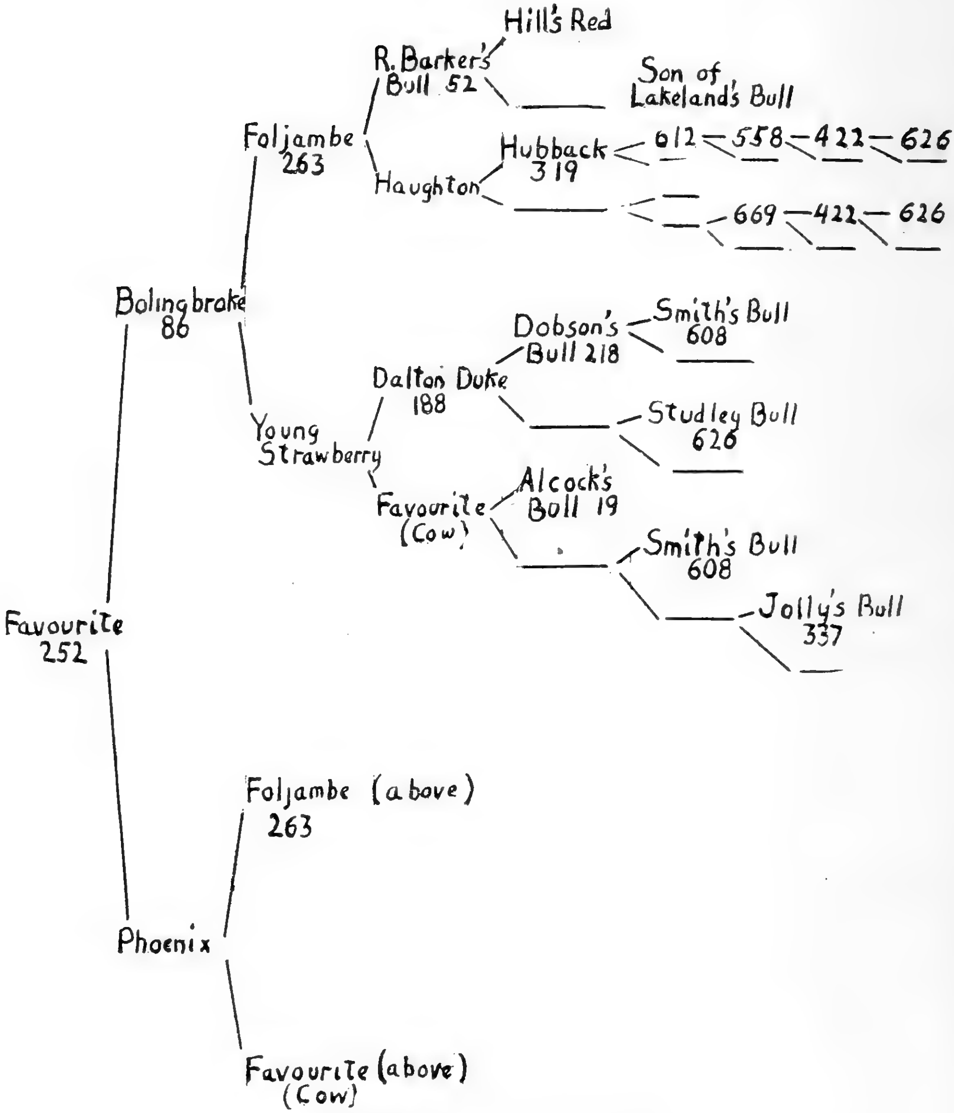


TWO AND THREE GENERATIONS OF BROTHER-SISTER MATING

Figure 2. For explanation of symbols see Figure 1. The effects of continued close breeding on homozygosis and resemblance due to relationship are analyzed in the text with the help of these diagrams.

through six independent chains, *S-T-D*, *S-E-D*, *S-T-U-E-D*, *S-T-F-E-D*, *S-E-U-T-D*, *S-E-F-T-D*. The formula is thus $2(\frac{1}{2})^3 + 4(\frac{1}{2})^5 = \frac{3}{8}$ or 37.5 per cent.

With three generations of brother-sister mating (Figure 2b) we encounter for the first time ancestors of the sire and dam which are inbred. There are as before two chains of two generations each by which sire and dam are connected through their parents, and in addition, four chains of four generations each, by which they are connected through their grandparents. Similarly we find eight chains of six generations each tracing to their great-grandparents. The parents of the sire and dam are themselves 25 per cent inbred, having one generation of inbreeding back of them. The formula thus becomes $2(\frac{1}{2}^3 \times 1.25) + 4(\frac{1}{2})^5 + 8(\frac{1}{2})^7 = \frac{1}{2}$. The individual *X* is 50 per cent inbred. The reader will have no difficulty in carrying the results to further generations and discovering that the limit under indefinitely continued inbreeding is 1, complete homozygosis, as it should be according



PEDIGREE OF FAVOURITE

FIGURE 3. Charles Colling's bull, Favourite 252, might be considered the foundation bull of the Shorthorns, as his blood became more widely distributed in the developing breed than that of any other bull. Favourite was inbred to a considerable extent, 19.2 per cent, which means that he was 19.2 per cent less heterozygous than the random-bred foundation stock. As an illustration of his influence in the early history of the breed it may be mentioned that forty years after Favourite's death there was a closer relationship between him and the cows of the famous Dutchess strain, bred by Thomas Bates, than between ordinary parent and offspring.

to theory. The results in regular systems of breeding, such as continued brother-sister mating, it should be said, can be worked out much more simply by special methods.[5] The case is merely brought up here to show the application of the general formula which must be used in dealing with the irregular systems encountered in ordinary pedigrees.

The Pedigree of Favourite

As an example of such an irregular case, let us take the pedigree of the bull Favourite (Figure 3). None of the ancestors of the sire and dam (Bolingbroke and Phoenix) are shown as inbred, so that we merely need to count the generations in each path connecting sire and dam, add one and use as an exponent of $\frac{1}{2}$ to obtain the contribution of each path to the coefficient.

We find that Foljambe was the sire of both Bolingbroke and Phoenix. The contribution due to this connection is thus $(\frac{1}{2})^3$ or 12.5 per cent. Foljambe as Bolingbroke's sire is not connected with the dam of Phoenix. This disposes of all possible connections through Foljambe as the sire's sire. The sire's dam, Young Strawberry, is connected twice with Foljambe as the dam's sire through common descent from the Studley Bull (626). The latter is four generations back of Bolingbroke and seven back of Phoenix in each of two lines through her sire. These contributions are thus $(\frac{1}{2})^{12} + (\frac{1}{2})^{12}$ or 0.05 per cent, an almost negligible quantity. We have finally to consider the connections between sire's dam (Young Strawberry) and dam's dam (Favourite Cow). First we note that Favourite Cow was herself the dam of Young Strawberry. We have here a contribution of $(\frac{1}{2})^4$ or 6.25 per cent. The sire of Young Strawberry is connected with Favourite Cow through descent from Smith's Bull. The contribution is $(\frac{1}{2})^8$ or 0.39 per cent. This disposes of all connections. The work may be arranged as follows:

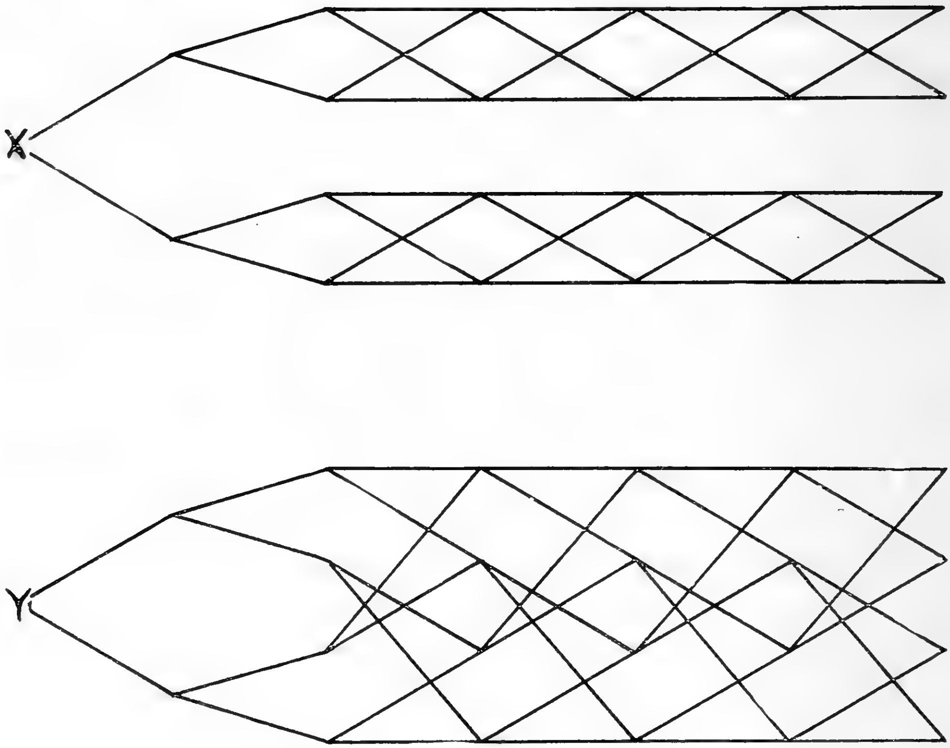
Inbreeding of Favourite (252)

Common Ancestor		Generation from		
Name	Inbreeding	Bolingbroke	Phoenix	Contribution
Foljambe	0	1	1	12.50
Studley Bull	0	4	7,7	0.05
Favourite Cow	0	2	1	6.25
Smith's Bull	0	4	3	0.39
Total				19.19

The total percentage of inbreeding is 19.2. It will be noticed that this would not be appreciably modified by omission of the remote connections through descent from Studley Bull and Smith's Bull. This coefficient means that Favourite departs 19.2 per cent from the genetic heterogeneity of the foundation Shorthorn stock in the direction of complete genetic homogeneity in other words has 19.2 per cent less heterozygosis.

Comparison with Other Measurements of Inbreeding

As the coefficient of inbreeding is derived from theoretical considerations, it will be well to consider for a moment how it is related to the degree of inbreeding in the popular sense. This is a somewhat difficult question to answer since inbreeding in the popular sense is a rather vague term. Pearl[6] has defined inbreeding on the basis of the ratio of the number of ancestors in each ancestral generation to the maximum possible number. The smaller the ratio the greater the inbreeding. This is a very different conception from the writer's, which is based on the reduction of genetic heterogeneity present in the foundation stock and is hence in the main a function of the ancestral connections between the parents. The contrast in the two conceptions can be seen very clearly by comparing the two pedigrees of Figure 4. The upper represents a mating be-



TWO METHODS OF BREEDING

FIGURE 4. Two pedigrees in which the number of ancestors in each generation remains the same, but in which the coefficient of inbreeding (F) of the individual X equals 0, while that of Y approaches 100 per cent. This is in accord with the results of experiments in inbreeding, where crossing two weakened inbred lines results in the return of normal vigor. Methods of calculating inbreeding that are based only on the ratio of the number of ancestors in each generation to the greatest possible number would not bring out this difference.

tween two individuals, each of which comes from a line in which brother-sister matings have been made generation after generation. The other comes from a line in which double first cousin matings have been made for generations. In each case there are two parents, four grandparents, four great grandparents, and four in every ancestral generation to the point where inbreeding commenced. They both, therefore, have the same very high coefficient of inbreeding according to Pearl's formula. According to the writer's formula, on the other hand, they are nearly as different as possible. The former has a coefficient of 0, the latter of nearly 1. The former is heterozygous in all respects in which the ancestral lines differ; the latter approaches perfect homozygosis.

With respect to vigor, the experiments of the Bureau of Animal Industry with guinea pigs, already referred to, demonstrate that the crossing of two weakened inbred lines results in a recovery of the vigor that has been lost. Thus generally speaking, the animal X (Figure 4), would be a vigorous animal; the animal Y would be weak in various respects. The experimental evidence is thus in accord with the coefficients 0 and 1 while as far as the writer knows there is no experimental evidence to indicate that the number of ancesters *per se*

has anything to do with the uniformity, vigor, prepotency or other characteristics.

Even if the measurement of inbreeding is based on the ancestral connections between sire and dam, there remain many possible formulae which could be suggested.

Perhaps the first thought would be to base the coefficient on the percentage of common blood in sire and dam. A little consideration will show, however, the unreliability of such a measure. Full brother and sister have 100 per cent common blood, but we know that much greater effects can be produced by continued brother-sister mating than appear in the first generation. Indeed, there might be 100 per cent common blood with no common ancestors of sire and dam for an indefinite number of generations. Let us suppose that the sire and dam trace to the same 1,024 individuals ten generations back, but have no common ancestors in later generations. Common sense and experiment tell us that their progeny could hardly be considered to be inbred at all. The coefficient of inbreeding of their progeny comes out only $1024 \times (\frac{1}{2})^{21} = (\frac{1}{2})^{11} = 0.05$ per cent in spite of the 100 per cent common blood.

Pearl[6] has attempted to separate from the amount of inbreeding as found by his formula a portion due only to relationship between the parents, this relationship being based on the number of animals common to the pedigrees of sire and dam in proportion to the greatest possible number of common ancestors. This comes closer to the writer's conception of inbreeding but in practice gives very different results from that given by the coefficient F. For example, continued mating of single first cousins gives results rapidly approaching 100 per cent according to this or any other of Pearl's coefficients, while the percentage of heterozygosis is decreased only by about 25 per cent in ten generations ($F = 25.2\%$). As far as the writer knows there is no purely experimental evidence to determine whether such a system as continued mating of single first cousins really approaches the effect of brother-sister mating in a few generations or whether it has the relatively slight effects indicated by the value of F. The writer, however, has sufficient confidence in the generality of Mendelian inheritance to believe that it is an advantage to use a coefficient which measures directly the consequences logically to be expected from it as well as measuring accurately the results of experiments in inbreeding and crossbreeding as far as these have been carried.

Measurement of Relationship

The measurement of relationship* is naturally closely related to measurement of inbreeding. In order to meas-

*Following is the formula where n and n' are the generations from the individuals X and Y to a given common ancestor A, and F_A, F_X and F_Y are the coefficients of inbreeding of A, X and Y respectively:

$$R_{XY} = \frac{\Sigma\left[(\frac{1}{2})^{n+n'}(1+F_A)\right]}{\sqrt{(1+F_X)(1+F_Y)}}$$

In the important case of sire and dam of the individual X we have:

$$R_{SD} = \frac{2F_X}{\sqrt{(1+F_S)(1+F_D)}}$$

Thus if the sire and dam are related but not themselves inbred, the coefficient of relationship is just twice the coefficient of inbreeding of their progeny.

ure the relationship between animals in such a way that direct comparison can be made with Mendelian theory, the most satisfactory method seems to be to find the coefficient of correlation to be expected with respect to a character determined wholly by heredity with no dominance. Such conditions give the maximum correlation and any other conditions give results strictly proportional. The correlation between parent and offspring or between full brothers should be 0.50 in such cases, according to Mendelian theory, in close agreement with many actual determinations. The correlation to be expected when the relationship is more complex can readily be calculated.[5]

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[1] The statements in regard to the early history of the Shorthorn cattle are largely drawn from *Shorthorn Cattle* by Alvin H. Sanders and *Farm Livestock of Great Britain* by Robert Wallace.

[2] King, Helen Dean, 1919. Studies on Inbreeding. The Wisner Institute of Anatomy and Biology, 175 pages. Reprinted from the *Journal of Experimental Zoology*. 26:1-98; 27:1-35, and 29:134-135.

[3] Wright, S., 1922. The Effects of Inbreeding and Crossbreeding on Guinea Pigs. *Bulletins* 1090 and 1121. U. S. Department of Agriculture.

[4] Wright, S., 1922. Coefficients of Inbreeding and Relationship. *American Naturalist*, 56:330-338.

[5] Wright, S., 1921. Systems of Mating. *Genetics*, 6:111-178.

[6] Pearl, R., 1917. Studies on Inbreeding. *American Naturalist*, 51:545-559; 51:636-639.

MENDEL "COMES BACK"

Scheduled to Attend World Dairy Congress with McCullum and Other World Famous Specialists in Dairy Science

There is to be a world dairy congress in Washington October 2 and 3, adjourned to Philadelphia for October 4, and to Syracuse, N. Y., October 5 to 10. This congress will be attended by the world's most famous specialists in dairy science.

There will be delegates here from practically every country of Europe, South America and Australia. Most of them will be men of national reputation, and many of international fame. There will be leaders in science, including Mendel, who discovered the astounding law of breeding and crossbreeding, and McCollum, who discovered the most revolutionary element of nutrition, known as "vitamins," without whose presence in food all nutrition is valueless and leads only to disease and death. Vitamins were unknown prior to 1912; today physicians and dieticians who are not informed as to their essential activities are not competent to practice medicine or prepare food.—*Washington Star.*

HERITABLE CHARACTERS OF MAIZE

XVI—Dead Leaf Margins

J. H. Kempton
U. S. Department of Agriculture, Washington, D. C.

DEAD leaf-margins is a character which becomes noticeable about the time the tassel appears, but before the flowers are mature. It affects the upper six to eight blades usually embracing a leaf or two below the ear node. The dead band varies in width from two to twelve mm., often wider at or near the base of the leaf, depending upon the intensity of expression. It is very conspicuous at flowering time when the leaves are fresh and green, but notwithstanding this fact was not noted until through chance a homozygous progeny was grown.

The leaves of most normal corn plants if allowed to dry usually wither first at the tips, the whole process being gradual, though it follows from the shape and structure of the leaf that the tissue dries more rapidly along the margins than along the midrib. However, with some plants the leaf margins are the first to wither and the blade gradually dries toward the midrib. The leaves of the variation *dead margins* would be confused readily with this latter form of drying, especially if seen late in the season, but the dead marginal tissue of the variation is apparent when the plant is at its maximum vigor and there should be no uncertainty if the plants are examined at the time of flowering.

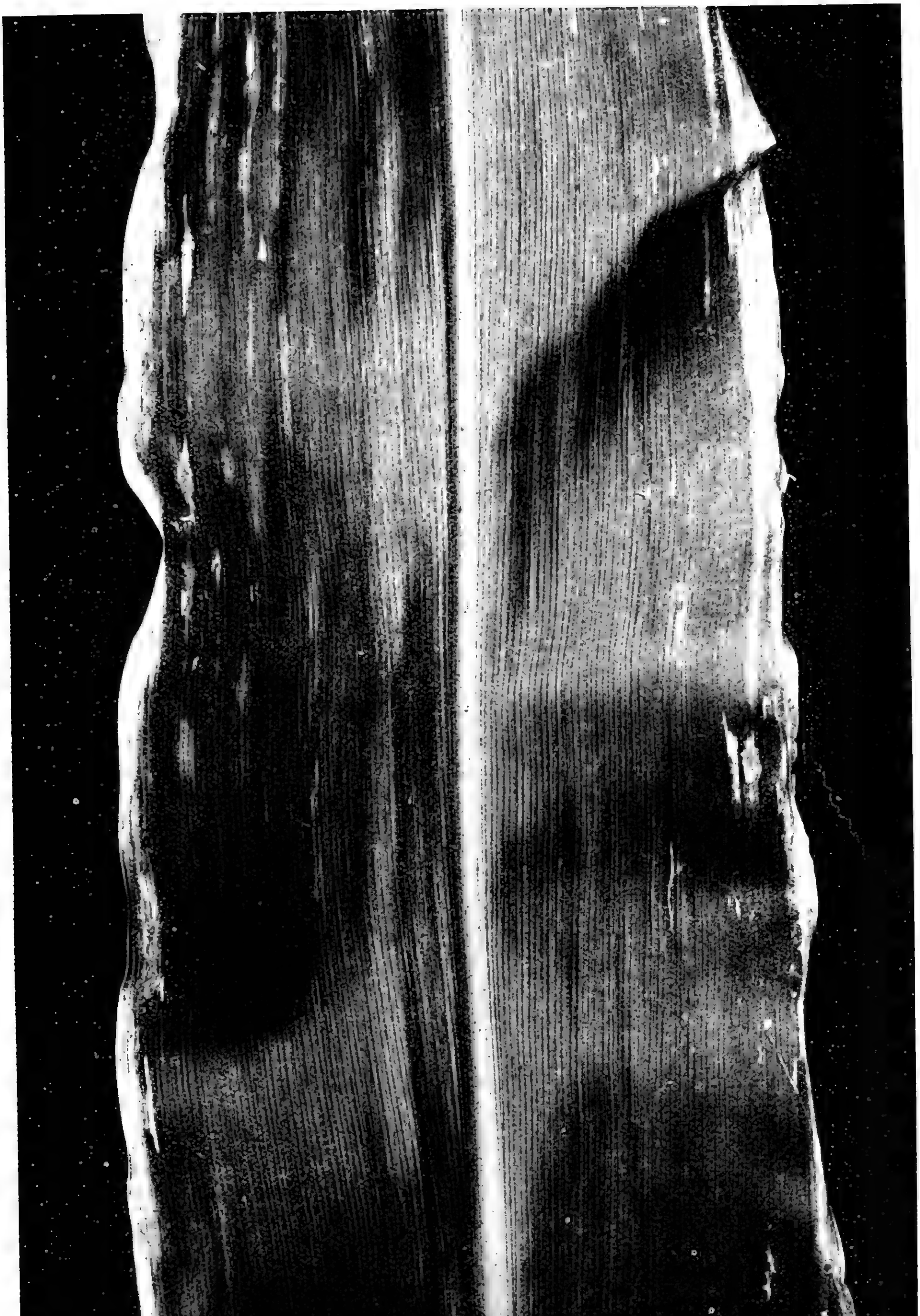
The strain now designated *dead leaf margins* was noted as a homozygous progeny in 1920. Its ancestry for five generations is known, but only the two generations preceding 1920 were the result of self-pollination, the others being crosses between sibs. The strain is descended from a hybrid between the Stowell's Evergreen variety of sweet corn and a dent variety from Southern Texas known as Brownsville. The hybrid was made at Victoria, Texas, in 1912 by J. H. Kinsler to develop a worm-resistent sweet corn.[1] Numerous lines of this original hybrid have been grown and the present is one of a number included for the study of various abnormal forms. Crosses have been made between plants showing the dead margin character and ten or fifteen other well-known aberrant forms. From the behavior of these crosses it seems that in addition to the character *dead margins* the progeny is affected with some lethal factor as many of the hybrid seeds fail to grow. Four hybrids, however, were grown successfully and all had normal leaves in the first generation while in the second generation dead leaf margins reappeared in approximately twenty-five per cent of the plants, though with a wide range in variability which reduces the reliability of classification. The classes for all four hybrids were 440 normal, 138 dead margins, the percentage of dead margins being 23.9 ± 1.2. From the nature of the character the plants must be classified at or before flowering time so that the character *dead margins* will not be confused with the natural death of the leaves.

From an analysis of small progenies *dead margins* seems to be unrelated genetically to brachytic culms, ramose inflorescence, sweet endosperm, sun red plant color, two factors for lineate leaves, and a chlorophyll disorder, yellow leaf spot.

[1]Breeding Sweet Corn Resistant to the Corn-Ear Worm. Collins, G. N. and J. H. Kempton. *Jour. Agri. Research.* Vol. XI, No. 11, pp. 549-572. December 10, 1917.

NORMAL AND "DEAD LEAF MARGIN" TYPES OF MAIZE

FIGURE 5. The plant at the left has just started to shed pollen, while the silks have not yet appeared. The upper eleven leaves on this plant show dead margins, the plant having produced a total of twenty leaves.



MAIZE LEAF WITH DEAD MARGINS

FIGURE 6. Natural size section of the blade of a maize leaf showing dead margins. The leaf margins of the upper blades die before the plant flowers, but the remainder of the blade completes a normal cycle.

Name	Birth	Death	Marriage	Consort	Rem.
BURRITT					New Britain, Conn.
Elihu	13 Dec., 1765	29 Jan., 1827	20 July, 1793	Elizabeth Hinsdale (Elijah)	
P1 Elihu Up	24 Dec., 1732	19 Mar., 1793	1794	Eunice Wakeman (Stephen)	
F1 Elijah Hinsdale	20 Apr., 1794	3 Jan., 1838	28 Oct., 1819	Ann W. Watson (John)	++
Elizabeth	22 July, 1796	1872	24 Aug., 1829	Hezekiah Seymour	+
Emily	12 Aug., 1798	1839	1838	Taylor	+
George	5 Dec., 1800	22 Aug. 1822	unm.		
Mary	18 Feb., 1803		26 May, 1825	Wm.* Williams	+
William	8 July, 1805		5 May, 1826	Clarissa Cole ( )	+
Isaac	31 May, 1808		16 Oct., 1832	Nancy Barnes (Selah)	s.p.
Elihu	8 Dec., 1810	9 Mar., 1879	unm.		
Eunice Wakeman	2 May, 1813		1st. 24 Apr., 1833	Jabez Cornwell	s.p.
" "			2d 17 Mar., 1853	A. J. Sawyer	++
Almira Bidwell	27 July, 1816		24 Nov., 1836	Stephen L. Strickland	+ ±
* Andrews says	Warren	Williams			

FAMILY PEDIGREE CARD—AS FILLED OUT

FIGURE 7. The family name appears at the top of the card. On the second line is entered the name of the male head of the family listed below, Elihu Burritt, born December 13, 1765. On the third line appear data regarding Elihu Burritt's father, born in 1732. Below the heavy line are listed the names of the children of Elihu Burritt and Elizabeth Hinsdale Burritt. Each card represents a family unit, and the universal adoption of such a system would make every card part of a record of human relationship that could be expanded indefinitely, to embrace the families of a country, or even of the entire human race.

A UNIVERSAL CARD SYSTEM FOR FAMILY PEDIGREES

HOWARD J. BANKER

Eugenics Record Office, Cold Spring Harbor, N. Y.

PRACTICALLY every genealogist has his own method for keeping track of the ramifications of the family network with which his studies are concerned. The inventions are numerous and sometimes remarkable and each worker is prone to believe that his own device is the best, or at least he has become so entangled in his system that it is impracticable for him to make any change.

Some of these schemes are too complicated or even bizarre to be of use to anyone but the inventor, others are cumbersome and unwieldy for ready reference, nearly all possess a degree of rigidity that materially limits their usefulness. Charting systems on any extended scale are cumbersome, permit little interpolation, and are limited to special lines of research. While of great value within their limitations for depicting final results, they are impracticable for use as a working guide for the general genealogist, except in very restricted fields. Systems of numbering are popular and these are highly efficient in certain cases. They are often devised to permit indefinite expansion and interpolation as the work proceeds and are simple to manipulate, but their use is restricted to special phases of genealogical research. One system of numbering is used for tracing ancestral lines, while a different system must be employed for lines of descent, and I know of no such system that will provide for all the lines of collateral relationship.

Believing there are many who are striving to find some more satisfactory method of ready reference that will guide them through all the labyrinth of family relationships, this paper has been written, trusting that the experience of the writer may be of some value to others. When we consider the complications in family relationships that may and often do arise from intermarriages, it is evident that no system can be devised that will be so simple that it will not require some study in its application. In other words, it is not possible to make such a system so mechanically perfect that it will be "fool-proof."

After years of practical work, the writer has developed what he believes to be the simplest possible system applicable to large and complicated family pedigrees. It is a card system capable of any amount of interpolation or expansion, and yet permitting at all times the ready tracing of the relationship of every individual to every other, if the connecting links have been properly recorded. In fact, it is conceivable that a genealogist specializing in some locality, could build up such a system that would furnish him with a complete synopsis and ready reference index to every family and individual in his field. Theoretically, if accurate data could be obtained, the entire human race could be included in a single, though enormous, system of related cards. Indeed, every collection of cards on this plan is a fragment of such a universal system, hence I have called this a "Universal Card System." If the plan were generally adopted and consistently maintained, it would be possible eventually to combine the card collections of many independent workers, without any change, into a single series. The only disadvantage being

	Name	Birth	Death	Marriage	Consort	Rem.
	BURRITT					
	Elihu	bp. 24 Dec., 1732	19 Mar., 1793	1749	Eunice Wakeman (Stephen)	
P₁						
F₁	Polly	1750	3 Nov., 1823		Joseph Mather	+
	Elijah					
	Naomi	1761	12 Jan., 1853	1790	Noah Stanley	+
	Isaac	1762	16 Mar., 1766			
	Elihu	13 Dec., 1765	29 Jan., 1827	20 July, 1793	Elizabeth Hinsdale (Elijah)	++
	Wakeman				Amelia Banks ( )	

ELIHU BURRITT'S FATHER'S FAMILY

FIGURE 8. The father of the family whose card is shown in Figure 7 is the fifth son, and his identity can be determined, in case of other individuals of the same name, by reference to dates of birth, death and marriage. It was not possible to trace the Burritt line any farther than this, so the third line is blank. Under the column headed "Remarks" are entered various reference marks useful to the worker. One plus sign indicates that the married children had families. Two marks indicate that these families have been carded. S. P. shows that there was no issue.

	Name	Birth	Death	Marriage	Consort	Rem.
	HINSDALE			1st	Ruth Bidwell (James)	
	Elijah	1 Apr., 1744	26 June, 1797	2d	Sarah Daniels	
P₁	John	13 Aug., 1706	2 Dec., 1792	8 Nov., 1733	Elizabeth Cole (Nathaniel)	
F₁	By	1st wife				
	Ruth	bp 30 Dec., 1770	d. y.			
	Elizabeth	6 Feb., 1775		20 July, 1793	Elihu Burritt	++
	Roxana	10 June, 1778			Ezekiel Andrews	+
	By	2d wife				
	Sarah					
	Ruth					

ELIHU BURRITT'S WIFE'S RECORD APPEARS ONLY ON HER FATHER'S CARD

FIGURE 9. To avoid duplication the women are not listed on separate cards, but appear only on the cards of their husbands and fathers—an arrangement that would not meet the approval of the Womans' Party. Thus, in filling out the cards it is necessary to enter the name of the woman's father after her name on her husband's card.

that in such case there might be found some duplication, which, however, could be easily corrected by simply discarding the more imperfect duplicates. In this way the material built up as the life work of one genealogist would have a high value to any other person working under the same system.

How the System Works

The system can best be explained by illustrations. Standard 5x8-inch cards, like those used in many card systems, are ruled as shown in Figure 7. This represents a typical card as filled out. Each card contains the record of a family group and its title is always determined by the male head of the family, whom we may term the propositus. On the topmost line at the left is printed in clear letters the surname of the family, in this case Burritt, and this is understood as pertaining to all in the column headed "Name." It is especially important

that this name be printed very distinctly. On the next line below is entered the given name of the propositus or head of the family, Elihu, and to the right the dates of his birth, death and marriage, as indicated, and the name of his wife, Elizabeth Hinsdale, which it is to be observed, is followed by the given name of her father in parentheses. The reason for this will appear later. On the next line marked "P^1" (that is, first parental generation), is entered the given name of the father of the propositus with his dates and consort as before. If he had more than one wife, only the name of the mother of the propositus should be entered here, in this case Eunice Wakeman, daughter of Stephen Wakeman.

Below the heavy line beginning at "F^1" (that is, first filial generation), are entered in succession the children of the propositus, with the proper data, if known. The names of female consorts should always be followed by the father's given name in parentheses, if it is known, but this is not necessary in the case of male consorts. Those who married more than once should have the record of all consorts given in succession as is shown for the ninth child, Eunice Wakeman Burritt, who married first Jabez Cornwell, and later A. J. Sawyer.

The column headed "Rem." may be used for various reference marks to serve the purpose of the worker. The writer has found it convenient to indicate whether the married children had families, the plus sign indicating that there were children, the double plus that the family has been carded, and s. p. that it is known that there was no issue. The cards provide sixteen lines for the record of children and it is rare that the space is not ample. In those few instances where more space is required it is best to carry the names "over" to the back of the card rather than use a second card. Usually there is room enough on the lower part of the card to enter footnotes, if desired, calling attention to variations in data. References to sources are conveniently entered on the backs of the cards, but the cards should not be used for general genealogical information. Such material should be entered on sheets in suitable folders.

It is evident that such a card may be filled out for any man and his immediate family and it is not necessary to pay the least attention to remoter relationships. If a collection of such cards is made covering a family or a community for several generations the relationships must all eventually appear. Cards are necessary only for males who had children. The compilation of the cards is, therefore, a very simple matter.

To see how the system works, let us suppose that we wish to trace the ancestry of Elihu in the Burritt line. His own card, Figure 7, shows that his father was another Elihu. Turning then to his father's card, Figure 8, which can be distinguished from others of, perchance, the same name, by the date of birth, name of consort, or other data, we find that there is no further record of the Burritt ancestry. The paternal grandparents are not known, but we do find the names of the father's brothers and sisters and their consorts and other data.

Let us now try a female line. We wish to know the ancestral connections of the consort of the propositus. Figure 7 shows that the consort of Elihu Burritt was Elizabeth Hinsdale and that her father was Elijah Hinsdale; we therefore turn to Elijah Hinsdale's card, Figure 9. If there are several Elijah Hinsdales carded, we can identify the correct one by observing that this Elijah Hinsdale had a daughter Elizabeth who married Elihu Burritt, and the date of marriage is confirmatory. Figure 9 shows that the father of Elizabeth married twice and that she was a daughter of the first wife, Ruth Bid-

Name	Birth	Death	Marriage	Consort	Rem.
BURRITT					
Elijah Hinsdale	20 Apr., 1794	3 Jan., 1838	28 Oct., 1819	Ann W. Watson (John)	
P1 Elihu	13 Dec., 1765	29 Jan., 1827	20 July, 1793	Elizabeth Hinsdale (Elijah)	
F1 Elizabeth	22 Apr., 1822	28 Oct., 1826			
George Hinsdale	28 Feb., 1826		20 Oct., 1849	Maria L. Parsons ( )	++
Anna Elizabeth	20 Nov., 1829		19 Apr., 1860	Joseph B. Hawkes ( )	+

THE FAMILY OF ELIHU BURRITT'S ELDEST SON

FIGURE 10. Elihu Burritt's son, Elijah (Figure 7) married Ann W. Watson, whose father was John Watson. They had three children, two of whom married and had families.

Name	Birth	Death	Marriage	Consort	Rem.
SAWYER					
A. J.			17 Mar., 1853	Eunice Wakeman Burritt (Elihu)	
P1					
F1 Alonzo Burritt	11 Feb. 1854				
James Hosmer	5 Aug., 1857				
Grace Alice	4 June, 1860				

FAMILY OF ONE OF ELIHU BURRITT'S DAUGHTERS

FIGURE 11. Eunice Wakeman Burritt's name does not appear on a separate card, but by reference to her father's card (Figure 7) it is seen that she married twice. By her first husband, Jabez Cornwell, she had no children. Reference to the card of A. J. Sawyer shows that she had three children by her second marriage. The complications caused by carding only the male heads of families are greatest in the case of widows who marry a second time, but this is much less than would be caused by having separate cards for both male and female heads of families.

well, daughter of James Bidwell, that her paternal grandparents were John Hinsdale and Elizabeth Cole, daughter of Nathaniel Cole, also that she had two full sisters, Roxana and Ruth, and two half-sisters, Sarah and Ruth. If we wish to trace her paternal ancestry further we then turn to the card of John Hinsdale which will give us the names of his parents, and so on to the end of the series. We may lay these cards in a row and read off the Hinsdale ancestral line as far as it goes. If the Cole ancestry is of interest, turn to the card of Nathaniel Cole and in the same manner follow the Cole line. Elizabeth Hinsdale's mother's family will be found on the James Bidwell card. In this way we may trace any ancestral line that we will, passing with equal ease to male or female lines. The children on each card furnish the connection to all collateral lines.

For tracing descendants or collateral relationships we start with the lists of children on any card. Thus in Figure 7 we note that the eldest son of Elihu and Elizabeth (Hinsdale) Burritt married Ann W. Watson, daughter of John Watson, they had issue and the family is carded. Turning then to the card of Elijah Hinsdale Burritt, Figure 10, we find the record of his children so far as known. This card shows also that his son, George Hinsdale Burritt, married and had issue and the family has been

carded. The latter's card will then show the next generation and so on.

In the case of a daughter, since the system is only for male lines, we turn to the card for her consort. Thus in the case of the daughter, Eunice Wakeman Burritt, we learn from Figure 7 that she married twice, that she had no issue by her first marriage, but had children by the second marriage, and this family has been carded. To find her family we do not turn to a card for Eunice Wakeman Burritt, for there is none, but we turn to the card for her consort, A. J. Sawyer, Figure 11, where we find the known data of this family. Observe that the fact that Eunice was a widow does not appear on this card, only her maiden name and the name of her father is entered. The double marriage in her case is found when we look up her record on her father's card. It thus follows that where a woman has two or more families by different husbands, each family appears on a separate card under the name of the husband. The facts, however, are readily determined on turning to her father's card. The several families of a man all appear on one card. This necessarily comes from carding only male heads of families and though it seems to involve an inconvenience in the case of the remarriage of widows, this is not very serious. On the other hand, to attempt to card both males and females as heads of families, involves many complications and would necessitate a large amount of duplication.

It appears evident, from the above account, that so far as the records are entered upon these cards it is a simple matter to trace a person's relationships in all lines of ascendants or descendants or in the endless ramifications of collateral lines through every degree of consanguinity and even passing out into the diffuse and endless realm of connection by repeated affinity.

Arranging the Cards

In practical use the worker may find it possible to reduce the labor of filling out the cards by omitting much of the data provided for, but care should be taken not to omit any datum which may be needed to identify different individuals of the same name, and all names should be given, if possible, as these form the connecting links with other cards in the system. The writer has found that it pays to record all the data that can be obtained, even though it takes some patience to do it.

As is readily seen, each card is an independent unit representing a family group and its location in the collection has nothing to do with its connection to other family groups. For general purposes it is most convenient to keep the cards in a simple alphabetical order. It is, however, possible to arrange and rearrange the cards repeatedly in any combination that may especially suit the purposes or whims of the worker. This need involve no other labor than that of sorting the cards and the use of such guide tags as the special arrangement devised by the worker may require. In studying ancestry the cards may be arranged in the order of the ancestral line under consideration. For determining degrees of collateral relationship, the cards may be arranged in two series with reference to any common ancestor and then by simply counting the cards the degree of relationship is at once determined. Other combinations may be worked out according to the purposes of the investigator. If one wishes to keep track of localities for the purpose of local history studies, the locality where the family chiefly lived may be entered on the top line in the column of "Remarks." Such cards may then be easily detected and temporarily grouped by localities when so desired.

The great advantages of the system

are its flexibility, its expansibility, the ease of interpolation, the simplicity of the record, and the constant maintainance of the connection of every card with every other related card in the entire system. To keep it up requires attention and a large amount of clerical labor, but no more than any other system which may be of less efficiency.

A View of Birth Control

BIRTH CONTROL, by JOHN M. COOPER, Ph. D., Associate Professor of Sociology, Catholic University of America. Pp. 96. Published by the National Catholic Welfare Council, Washington, D. C. 1923.

The abundant controversial literature on birth control contains few contributions of more weight than this statement of the official Roman Catholic position, and the reasons that are held to justify this position. The Church's attitude, briefly, is that birth control is permissible in proper cases, but only through the practice of continence, the use of all artificial contraceptives being condemned. The grounds underlying this position are set forth by Dr. Cooper in a remarkably persuasive way, and the chief contentions of the birth-control propagandists are then assailed one by one and badly damaged. Dr. Cooper's task is, of course, facilitated by the fact that nearly all the birth control propaganda is composed mainly of fallacies and puerilities, and is based on emotion rather than on reason.

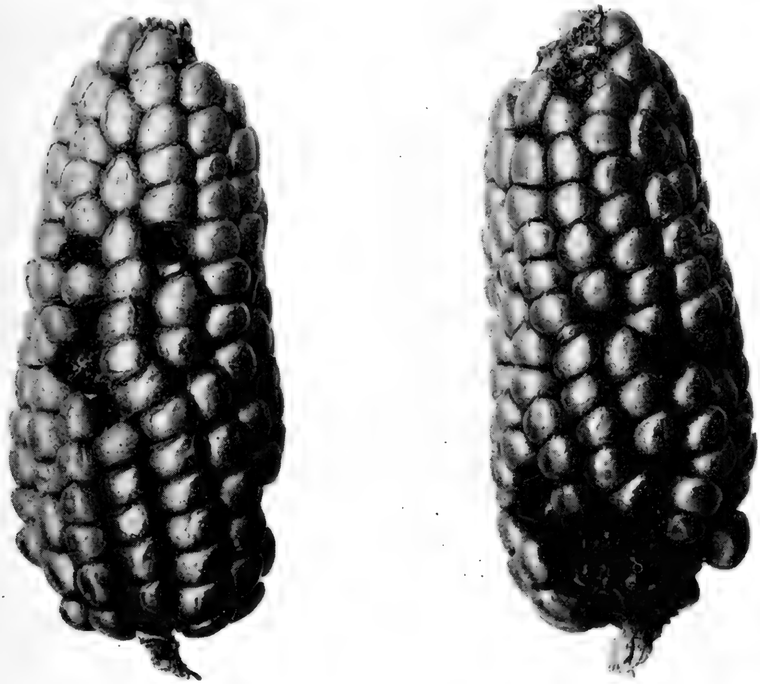
This is not to say that the reviewer accepts all of Dr. Cooper's premises, or all of his conclusions; or that other readers are likely to do so, unless they be Roman Catholics. But it must be frankly recognized that the author has met the birth control propagandists on their own ground and to a large extent beaten them. It is to be hoped that his attack will call forth replies that are of as high an order, in respect to logic and scholarship. The pseudo-scientific rhapsodies that have composed a large percentage of the "birth control literature" have been a glaring example of how a biological problem should not be debated.

The weak point of Dr. Cooper's position (and one which he does not at all attempt to evade) is the fact that he is arguing against a *fait accompli*: birth control is already here, and here to stay. Neither the authority of the Church, nor any other power, is likely to stop it. So far, no unprejudiced person doubts that it has done great harm to the race, eugenically; because it has been practiced more by the eugenically superior than by the eugenically inferior. There are two possible remedies for this serious situation: one, which the birth control propagandists have espoused, is to get the practice more widely spread among the inferior. This, for a variety of reasons, is a difficult if not hopeless task. The other is the constructive eugenic policy of getting such social and economic changes in effect as will prevent the superior from limiting the number of their births excessively. This, too, is difficult, but not hopeless.

Most biologists are convinced that the practice of birth control is desirable, within proper limits. But the question is still a very live one. No interested person can afford to overlook Dr. Cooper's concise and thought-provoking pamphlet.—*P. P.*

DEFECTIVE SEEDS IN MAIZE--AN ANCIENT CHARACTER

Frederick D. Richey
Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture



DEFECTIVE GRAINS AT LEAST THREE CENTURIES OLD

Figure 12. This ear of maize was unearthed in an Indian graveyard in Peru, unused since the time of the Spanish Conquest. The ear is, therefore, at least three hundred years old, and may be centuries older. One of the defective grains is shown in each view. Defects of the endosperm exactly similar in external appearance are found today in self-pollinated strains of maize, and it is interesting to speculate whether any of these modern abnormalities are genetically the same as this ancient defect.

THE ear of maize illustrated in Figure 12 was obtained from an Indian grave at Rontoy, Peru, on March 24, 1923, by Mr. D. S. Bullock of the Bureau of Agricultural Economics, who presented it to the Office of Cereal Investigations, Bureau of Plant Industry, on April 19, 1923.

The Indians were placed on reservations some distance from Rontoy at the time of the Spanish Conquest, and the burying-ground in which Mr. Bul-

lock obtained this ear has not been used since that time. The ear, therefore, is at least 300 years old and, of course, may be much older. It is not unlike ears of maize that have been received from time to time from various parts of South America, and is of some interest in this connection.

Defective seeds as a heritable character of maize were reported first by Jones.[1] More recently Lindstrom[2] and Mangelsdorf[3] have reported on other specific types of defective seeds, and many additional types are known. In fact, among the most common and apparent effects of self-pollinating maize for the first time are ears showing segregation for some type of defective seeds.

In view of these facts it seems of special interest that the Rontoy ear contains several defective seeds, one of which is shown in each of the illustrations. These seeds apparently are of the type that has been called "compressed" when it has occurred in the author's strains, although a disinclination to dissect the Rontoy ear has prevented a very close examination. On segregating ears these "compressed seeds" observed by the author, are evident only by their smaller size. Their classification is difficult because of intergrades due either to normal differences in kernel size, the complimentary action of genetic factors, or both of these causes. A study of the mode of their inheritance has not been attempted by the author beyond obtaining definite evidence that they are inherited.

Is the gene that was responsible for the defective seeds in the Rontoy ear the same as one of the many known to exist at present? Has it persisted individually in the germ-plasm throughout the countless generations since the Rontoy strain and our modern sorts were one? Or has it been eliminated by natural selection only to recur from time to time as a mutation? These and other questions are interesting bases for speculation, but, unfortunately lead nowhere. The fact remains, however, that maize grown by the Indians of Peru 300 or more years ago carried defective seeds entirely similar phenotypically to some of those found today whenever maize is self pollinated.

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[2] Lindstrom, E. W. Endosperm Defects in Maize. *Journal of Heredity,* 14:127-135. 1923.

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The Changing Environment

A poll of sixth-grade pupils in St. Louis revealed that of 5,376 children questioned 40 per cent had never seen a sheep, and 17 per cent had never looked upon a pig. Of every hundred children, 12 had never seen a cow. It has been suggested that a cow and a pig be placed in the municipal zoo.

Dearborn Independent.

COMPLETE SEX-TRANSFORMATION IN THE DOMESTIC FOWL

F. A. E. Crew

Animal Breeding Research Department, Edinburgh University, Scotland

IN FEBRUARY, 1921, a Buff Orpington was brought to this Department. During the preceding January its owner had decided that there was far too much crowing for a city pen, and she had had the male bird killed. Shortly after this it was noticed that a great deal of crowing was still coming either from the pen or from somewhere nearby, and at length it was found that one of the hens was responsible for the noise. This bird was three and one-half years old, pure-bred, and had ceased to lay in the late summer of 1920. She had raised several broods of her own chickens. On her arrival here she exhibited the classical signs of early ovarian disease, the head-furnishings were larger than those of a typical hen of her breed, the left spur was three millimeters, the right one two millimeters in length. The plumage was entirely henny. She crowed persistently, but as one practising, and her sexual behavior was completely indifferent.

In April, 1921, the vascular tissue of the head had become markedly turgescent so that the eye appeared to be deepset amid flaming red congested flesh; and the comb, wattles and spurs had progressively increased in size. The bird had begun to moult irregularly, and was suffering from an intractible diarrhoea, losing weight and seeking solitude. By October she had become completely cocky-feathered, though she could never retain her tail sickles. The spurs were now one centimeter in length and the legs had assumed the red tinge which characterizes the male of her breed. She was carefully nursed through the winter and by February, 1922, she had overcome the more urgently dangerous symptoms, was crowing lustily with a challenging note, and was readily attracted by hens, which, would squat at her approach, the sexual act being performed. "He" fought with every male in the yard and was gently courteous to hens. In fact, only by one with an intimate knowledge of poultry, or by placing it alongside a "real" male, could it be told that this bird was different from a typical male. Its stance was different from that of a cock, for the bird was shorter on its legs and these were set at a different angle with the body.

On February third, the bird was penned with a virginal Buff Orpington far removed from all other birds. This hen was laying, and the eggs which she had laid during the previous fortnight were incubated and found to be unfertilized. Her mate performed the sexual act regularly and fluid passed into the cloaca of the hen was withdrawn and examined. On April 23rd a few living spermatozoa were identified. On June sixteenth the hen became broody and was set upon nine of her own eggs laid during the previous eighteen days. On July seventh two chickens were hatched; the other eggs were clear. By this time the father of these chickens had again become seriously ill and a large tumor could be felt cephaled to and discreet from the gizzard. The bird began to lose weight rapidly and suffered from serious diarrhoea. On December twenty-ninth "he" fell into an opened drain and was drowned. At the time of its death its comb measured four centimeters at its highest point, the right spur was four centimeters, the left five centimeters long, the scanty plumage was entirely cocky.

On dissection the liver was seen to be of great size, weighing 340 grammes, and studded with rounded areas of what proved to be caseating tuberculous material. The intestinal tract was also the seat of tubercular lesions. Lying in the situation of the ovary was a rounded mass, seven by four centimeters in size, with its purple surface mapped with raised yellow areas. This mass weighed 52.5 grammes, and incorporated in its dorsal aspect there was a body exactly resembling a testis whilst a similar body was situated in the equivalent position on the other side of the body. These testis-like bodies measured three and a half by two centimeters, and had even outlines and surfaces. The adrenals were larger and more prominent than is usual and there was nothing noteworthy about the thyroid or pituitary. On the left a thin straight oviduct could be traced, its diameter at its caudal widest part was three millimeters, and paired vasa deferentia were clearly discernable.

On sectioning, the tumor mass proved to be an ovary practically completely destroyed by tuberculosis; the testes-like bodies were seen to be testes in a phase of reduced activity. The seminiferous tubules were precisely similar to those of the testis of a normal cock, consisting of a well-defined basement membrane lined by seminal epithelium showing every stage of spermatogenesis. They differed from a very active testis in that they were smaller in size and showed fewer mitotic figures; ripe spermatozoa were present, but not in large numbers. The intertubular tissue, as in the case of a normal cock, was present in small amount and consisted of connective tissue only; no luteal cells were to be found. Only one Wolffian body was sectioned, it resembled an epididymis rather than a parovarium.

The bird described had been, up to the age of three and a half years, an unremarkable hen; she had laid many eggs and had raised many of her own offspring. Her history was intimately known, for her owner kept but few birds. In the autumn of 1920 she began to suffer from disease of the ovary; the ovarian tissue as progressively destroyed, and the effects of this pathological castration were seen. But the conditions which were created were those favorable for the differentiation and growth of spermatic tissue. New sex-cords developed from the germinal epithelium and spermatic tissue was differentiated both in the left gonad and also in the atrophic right. The bird became anatomically equipped to function as a male, for with the development of the testes the Wolffian ducts were stimuluated to form functional vasa deferentia and the cloacal apparatus of the male was developed. Synchronously with the replacement of ovarian by spermatic tissue the oviduct underwent atrophy. The bird functioned as a male and actually became the father of chickens. Under these circumstances, in which a "determined" female becomes a "somatic" male as a result of a definite change in its metabolism, it would be expected that the proportion of the sexes among its offspring would be one male to two females. Of the two chickens one is a male, the other a female; they have been mated, and their offspring are typical Buff Orpington chickens.

THE RACIAL PROSPECT IN SOUTH AFRICA[1]

THE future of the various races of South African natives can be foretold with much probability. The Bushmen and Koranas are rapidly passing away as distinct races, the remaining individuals being steadily absorbed by the other races, mainly by the mixed Hottentots, and in one hundred years it will be difficult to find a pure Bushman or Korana. The Hottentots will survive longer as a distinct race. In Namaqualand, where there will never be any very extensive white settlement, they may survive in a state of relative purity for some hundreds of years, and so also in Southwest Africa, but in other parts of South Africa they are bound to become absorbed into the mixed Cape Race or the Bantus.

But the future of the Bantus is very different and provides those of us who dwell in South Africa with our most alarming political problem. Almost all colored races of man go down before the onslaught of the white man's diseases and alcoholic drinks. The South Sea Islander, the Australian, the Bushman are all passing away, but the Bantus thrive, and today are multiplying twice as fast as the whites. Every Kafir wishes to have a family and generally marries young. Polygamy has been recognized from time immemorial and even Christian missions have to compound with it. Since devastating native wars have ceased under the *Pax Britannica*, the sexes have become more equalized, and polygamy is now the exception, but it is still largely practiced in the native territories. Every woman becomes the mother of children and many have large families. At present the Kafirs or Bantus outnumber the whites by about five to one, and every year the proportion of black to white is becoming larger. Before very many years it must be ten to one, and before the present century draws to a close it seems very certain that the Kafir will rule the whole of South Africa, and white civilization be replaced by black. There will be no need for the Kafirs to rise in rebellion in order to gain commanding power; they have only to breed and to study. The Kafir chiefs are often men of great intellect, and they are certainly better statesmen than many of the whites. They look far into the future. In the first half of the nineteenth century there was a continuous succession of Kafir wars, and the blacks showed that they must be classed as formidable warriors. But since the Zulu War in 1879 there has been no serious native war. There has, however, been far more serious native peace. When there was a little rising in Zululand about a dozen years ago and hundreds of Zulus were shot down by machine guns, the Zulu mothers quietly said, "We can breed sons quicker than you can shoot them down."

In olden times the Hottentots were the more or less docile slaves of the Dutch and French immigrants. They were intellectually and physically too inferior to the whites ever to be any source of direct danger. But unfortunately the very inferiority of the Hottentots has given rise to the idea in the minds of many of the white colonists that all colored races are inferior, and that there is really no danger from the Kafirs, and as a result the Kafirs have been encouraged to come into Cape Colony, most of which was really originally the country of the Hottentots and the Bushmen.

Already the Kafir has displaced the

[1] Reprinted from *Natural History*, May-June, 1923.

Hottentot as the laborer in most of the towns, on the railways, and on most of the farms of the middle of Cape Colony. He is also displacing the poorer class of whites and the less intellectual. In most countries the unskilled labor is performed by this class of whites, but here in South Africa the Kafirs can do it more cheaply than the whites, and can do it just as satisfactorily. Hence there is nothing for the poor white man to do. Already we have in South Africa tens of thousands of a class that has no counterpart in any other country in the world—the "poor whites"—not well enough equipped through intellect and education for the performance of skilled labor and with no unskilled labor for them to do. Every year sees the problem getting worse. The government tries to help by creating labor colonies, land settlements, and through other schemes, but for every thousand relieved, two thousand more seem to arise.

This class of "poor whites" with no steady work to do, and too often on the border of starvation, is a constant source of danger, being a ready tool in the hands of unscrupulous politicians. In 1914 there was quite a serious rebellion and this year again there was an attempted revolution in the Transvaal. Both these uprisings have been put down by the government, but the disease continues. Until recently the Kafir competed only in unskilled labor; now he is entering the fields of skilled labor, and very steadily but surely displacing more and more whites.

Many years ago Balfour said that South Africa had a terrible problem in the native question, and he added, "I do not envy the man who has to tackle it." Whether for good or for ill to the world the Bantu and Negro tribes are going to play a big part in the future. It is well we should study them.

ROBERT BROOM.

Early Civilization

MAN is one, civilizations are many. The superiority of our civilization over all previous ones is not indisputable. Civilization, like mankind, does not proceed unerringly in evolutionary progress without some weaknesses and degeneracies. It would seem that we need clearer notions of man and civilization, a concept of civilization which will embrace a great variety of separate yet similar phenomena, thus making apparent the homogeneity of all civilizations with reference to their principal constituent. Familiarity with early man and early civilization will help clarify our ideas, for "the early world presents an ideal field for the study of the achievements of man, for the extension of our understanding of cultural problems and our appreciation of the great range of civilization."

In this mood Dr. Goldenweiser would have us approach his volume, *Early Civilization*[1]. The book is an excellent analysis and compendium of the rudiments of anthropology. The style is that of the methodical lecturer. Each essay is a unit in itself but is not without constant reference and relation to the other members of the series.

The book is divided into three main parts, the simplest of which is the first, consisting of descriptions of five primitive test tribes, and the author's reflections on the phenomena outlined in the first five chapters. The second part is a comparative study of the various component factors of civilization and their relations, and another chapter of reflections. The third part ascends to psychic theory. Erudite critiques of theories of early mentality characterize this portion of the book, and the summary chapter concludes the work.

[1] Published by Alfred A. Knopf. New York. 1922. Price $3.50.

Throughout Dr. Goldenweiser is very zealous in his effects to correct erroneous but prevalent ideas, such as those regarding the sense equipment of the primitive, his capacity for sustained labor, his resistance to pain. The author's arguments for belief in the importance of diffusion, the independent origin of geometric and realistic patterns in primitive art, are tenable as well as his disbelief in the comparability of children's art and primitive art.

The author is not without the fault of traveling the by-paths instead of the highway to reach his destination. Dr. Goldenweiser's attack on the doctrine of "inheritance by magic" is justified, but his acquaintance with breeders, that is, scientific breeders, needs to be cultivated. Citing examples of latter-day supernaturalism he states, "We hear of children born during the French Revolution with the revolutionary emblem on their chests; or again, a mother, frightened by a frog, gives birth to a child with a birthmark resembling a frog. . . No more than Jacob could resist the temptation of interpreting by a mechanism such as the above the peculiar and varied coloration of his sheep, can the modern fencier (fancier?) overcome the suggestive influence of the many instances in his experience where an interpretation through pre-natal influence *may* be made, and he makes it forthwith."

On the whole, however, the book does not abound in infelicities of matter or expression. It fulfils its function as an introduction to anthropology. As such it is worth reading and readable, a book for both initiate and novice.

F. L.

The Status of Evolution

Allegemeine Abstammungslehre, by Dr. Bernhard Duerken, Professor at the University of Breslau. Pp. 205. With 38 text figures. $1.00. Berlin, Verlag von Gebrueder Borntraeger, 1923.

Professor Duerken's book is written for the much-exploited "general reader," and attempts to give a picture of the real status of the theory of evolution. He discusses the evidence in favor of evolution, taking up the conventional kinds—paleontology, embryology, comparative anatomy, etc.—and reaches the safe conclusion that there can be no real question as to the fact of evolution.

He then goes on to discuss current hypotheses regarding the method in which evolution has taken place. He groups these under the two heads of Darwinism and Lamarckism, and after an acute destructive criticism, on the ground of both logic and fact, concludes that neither of them is tenable. As to explanation of the mechanism of evolution, he remains what might be called an agnostic.

Every critical reader will find abundant matter for controversy in such a presentation. Nevertheless, the simply and clearly written book, with its insistence on clear thinking, might be read with profit by every student. It ought to serve an important purpose in the era which the author sees immediately ahead, when new developments in biology will finally bring the indisputable causes of evolution to light.

P. P.

THE FAVORITE OPERATION AMONG THE ANCIENT PERUVIANS

FIGURE 13. Naturally it is not possible to determine by an examination of skeletal remains whether the Incas indulged in the luxury of having their tonsils and appendices removed. Of all the surgical operations of which time has left us any record trephining the skull was by far the most popular in ancient Peru. The owner of this skull appears to have been the holder of the long-distance record for having holes cut in his skull. Not the least remarkable part of this operation was that the patient survived, at least long enough for the bone to show evidences of healing. (Photograph by courtesy of the National Geographic Society.)

RAW MATERIAL FOR THE ANTHROPOLOGIST

FIGURE 14. Some of the bones and mummies discovered by the Yale University-National Geographic Society Expedition in 1915, as they were removed from the burial caves. (Photograph by courtesy of the National Geographic Society.)

BONES OF THE ANCIENT PERUVIANS

A Review

THE July-September number of the *American Journal of Physical Anthropology* is devoted to a treatise on "Human Skeletal Remains from the Highlands of Peru," by George Grant McCurdy. The material was secured in 1914 and 1915 by the Peruvian Expedition of Yale University and the National Geographic Society, conducted by Professor Hiram Bingham, and was mostly from caves in the upper Urubamba Valley, the principal seat of the Inca civilization.

The ancient burials were largely in caves where the mummies were placed in a sitting posture wound with braided grass rope and supported by "seat-rings" of withes, twisted together and loosely wrapped with cords or strips of bark.

Of 341 crania examined, 147 showed the so-called "Aymara type" of deformation, "produced by circular constriction and compensatory elongation." Skulls of both sexes were deformed and a larger proportion of female skulls, sixty per cent, than of male, forty-three per cent. In cases of very pronounced deformation the foramen magnum may be reduced in size and the spinal cord constricted. Also the cranial capacity was found to be somewhat less in such skulls. Hence the conclusion is drawn that "excessive Aymara deformation has an inhibitory effect on the growth of the brain." It is easy to understand that the growth of the skull may be restricted by the tight-fitting woolen caps that the natives of the Peruvian highlands put on their babies' heads—and apparently leave on indefinitely.

By far the longest chapter is devoted to surgery, and relates mostly to the trephining of the skull, an operation which evidently was popular among the ancient Peruvians. Forty-seven trephined skulls were found in a series of 273 adults and in several cases more than one operation was performed, one of the skulls having five apertures. Of the forty-seven trephined skulls twenty-nine were recognized as males, sixteen as females and two as youths. Twenty-six cases were successful, and partial healing occurred in eleven other cases. The operations were chiefly on the left side of the head, which with other facts is taken to mean that the principal object was to relieve depressed fractures produced by star-shaped stone club-heads, which seem to have been the favorite weapon of the time.

That so many female skulls were trephined makes it seem questionable that the injuries were received in warfare. Did the women fight in war with the men, or was clubbing a neighborhood pastime?

Other injuries and abnormalities of the skull and other bones are also described in detail, including especially the teeth, which were often imperfect or diseased. There were no cases of supernumerary teeth, but milk teeth were often retained and caused irregularities in the permanent teeth. Pyorrhea, alveolar absesses, and other dental diseases were recognized in many cases. "In 12 jaws out of 422, the teeth had all disappeared prior to the decease of the individual."

No comparisons are made in relative frequency of the abnormalities or diseased conditions in other parts of the world. Though the colonizing policy of the Incas may be supposed to have resulted in a great deal of mixing of tribal stocks in some of the outlying regions, there probably was a general condition of inbreeding and congestion with resulting pressure upon the means

of subsistence. This is indicated by the very specialized systems of agriculture that were developed, as well as by the precautions that the Incas are reported to have taken against famines, which are confirmed by the discovery of many ancient storehouses. With the ancient precautions neglected, many districts that were terraced with stone-work, and no doubt were cultivated very intensely in ancient times, have been abandoned.

The Diseases of Children

Saeuglingskrankheiten, by Dr. Walter Birk, Vorstand d. Univ.-Kinderklinik zu Tuebingen. 5. und 6. umgearbeitete Auflage, 10-17 Tausend. Pp. 282, with 26 illustrations. Price $1.40. Bonn, 1922, A. Marcus & E. Webers Verlag.

Dr. Birk presents a clear, comprehensive and well-organized discussion of the diseases of infancy in this volume, which forms part I of his "Leitfaden der Kinderheilkunde," a second volume being given over to "Kinderkrankheiten." He fully recognizes the importance of heredity in the varied problems which the pediatrist meets, although he does not go into this side of the case as fully as some might desire. Speaking of twins, he remarks that they have the most divergent constitutions, in spite of the identity of their surroundings. As to rickets, he declares that eighty per cent of the children in Germany are effected at one time or another, and that inborn predisposition plays an important part. The current theory that rickets is due to lack of vitamines he dismisses as not in accord with the clinical facts. He notes that the negroes in Africa are free from this disease, while it is extremely prevalent among the negroes of North America. The importance of rickets in forming the shape of the female pelvis is often not recognized until the girl becomes a mother. It is in this way of first-rate importance to eugenics. Dr. Birk closes with a brief review of the infant welfare movement. P. P.

Origin of Mongolian Idiocy

Mongolian idiocy is a typical form of amentia, taking its name from the fact that the children born with this condition often have a facial expressiin resembling that of the Mongolian race. Its cause is obscure, but has been set down by various writers as "uterine exhaustion," since the last child in large families seems to be more often affected than others. Statistics on the subject have been fragmentary, however. Available data have been reworked by Hornell Hart, who contributes a note to the *Journal of the American Statistical Association,* XVIII: 900-903, September, 1923. He finds that a Mongolian ament is twenty-three times as likely to be born to a mother forty years old or over, as to a mother between the ages of twenty and twenty-four. It is therefore clear that the condition is correlated with the mother's age; but the data are not sufficient to show whether the mother's age is significant because of a possible deterioration in the quality of the germ-plasm, or merely because the older mothers are likely to have had more children; or for some other reason.

THE TORTOISESHELL CAT

F. A. Hays
Massachusetts Agricultural College

GENETICISTS are almost universally agreed on the following points regarding color inheritance in cats:

1. That black males mated to yellow females give tortoise females and yellow males.
2. That yellow males mated to black females give tortoise females, an occasional black female, and all black males.
3. That black males mated to tortoise females give both tortoise and black females and both yellow and black males.
4. That yellow males mated to tortoise females give both yellow and tortoise females, an occasional black female, and both yellow and black males.

A few tortoise males have been recorded. Such males are considered sterile. The two most important questions in this connection are:

1. Why are tortoise males not of frequent occurrence?
2. Why are tortoise males sterile?

The first of these questions may be elucidated by a brief statement of the method of inheritance of the factors for black and yellow, which when together make the tortoise pattern. The results of the four types of matings enumerated above clearly place the two factors for coat color in the category of sex-linked factors as Little[3]* suggests. In such case the male progeny receive an X-chromosome from their dam carrying either the gene for black or yellow color. This chromosome is paired with the Y-chromosome from the sire. This assumed† Y-chromosome is apparently devoid of genes for the colors in questions so that the sons inherit their color only from their dams. Daughters receive an X-chromosome from both sire and dam and thus provide a mechanism for both the black and the yellow factor to occur in the female zygotes. The combined action of these factors gives the tortoise pattern.

Different concepts of the possible explanation for the occurrence of a few tortoise males need not be discussed. The sterility in such males has been explained by some as being due to imperfect sex development or to the partial transposition of the female to the male sex. Careful examination of the fetuses of seventy pregnant cats by Doncaster and Bember[1] has not revealed a single case of confluence of blood vessels or fused chorions.

A means of explaining the infrequent occurrence of tortoise males and their sterility, as well as the appearance of the few unexpected black females in crosses 2 and 4, exists in the crossing-over phenomenon. We may assume that a cross-over only infrequently occurs between the X- and Y-chromosomes of a yellow male because the genes occupy loci in very close proximity, and moreover that cross-overs sometimes take place in the two X-chromosomes of females. If a male with crossing-over between

* For numbered references, see *Literature Cited* at end of article.

† DeWinivarter has apparently discovered two types of spermatocytes in the cat, one carrying seventeen and the other eighteen chromosomes. He was, however, unable to trace the chromosomes farther than the spermatocyte stage. Because of the behavior of the colors black and yellow in inheritance, we may be justified in assuming the existence of the Y chromosome in half the spermatozoa until its absence is proven.

the X- and Y-chromosomes is mated to black females he should sire some tortoise males.

Spermatogenesis in tortoise males is not normal according to Cutler and Doncaster.[2] This may be due to the abnormal character of their Y-chromosome, since the Y-chromosome has been thought not to be the carrier of character genes until the discovery of "male-linked" by J. Schmidt[4] in fishes.

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[2] Cutler, D. W. and L. Doncaster. On the Spermatogenesis of the Tortoiseshell Tom Cat. *Jour. of Gen.* V, No. 2, 1915.
[3] Little, C. C. Preliminary Note on the Occurrence of a Sex-Limited Character in Cats. *Sci.* N. S., XXXV, p. 784, 1912.
[4] Winge, O. A Peculiar Mode of Inheritance and Its Cytological Explanation. *Jour. of Gen.* XII, 2, 1922.

THE CAUSES OF TWINNING

A Review

HEREDITY is a new standpoint in biology, reached through more intensive and constructive interest in the processes of reproduction. Though much more attention has been given in recent years to the study of the transmission of characters, there is an equal or greater need of understanding how the characters are brought into expression in the development of new individuals. Greater interest may be claimed for the expression relations because they are influenced by the environment, while transmission is independent of the environment. Probably on account of so much debate on the question whether environmental influences are entirely excluded from transmission, the need of more definite knowledge of the relations of environment to expression is commonly overlooked among students of heredity.

Thus it happens that a book which does not profess to treat of heredity, and even omits the word from its index, is nevertheless to be considered as an important contribution to the subject. The book in question is Professor Newman's "The Physiology of Twinning," a volume of the Science Series of the University of Chicago.[1] The writing and printing are well done, the treatment is not over-technical, and the reader is assisted by about seventy illustrations very skilfully drawn by Mr. Kenji Toda. The general interest of the book might not be suspected from the limited subject, but the treatment leaves no doubt that twinning is an important "lead" toward a better understanding of some of the fundamental problems of reproduction.

Development of two or more embryos from one egg is considered as the only genuine twinning, and this phenomenon is traced through all of the principal groups of animals, with special consideration, of course, for the armadillos. With these animals twinning is a regular occurrence and is supposed to be connected with a delay of development at the period of gastrulation, which Professor Newman considers as a general cause of twinning, and subject to environmental influence. The process of twinning is conceived fundamentally as a form of fission, analogous with dichotomous branching of plants. Fasciation is

[1] The Physiology of Twinning, by Horatio Hackett Newman, Professor of Zoology, University of Chicago. Pp. 230, xii. Price $1.75. The University of Chicago Press. 1923.

another plant phenomenon that might be compared with twinning in animals.

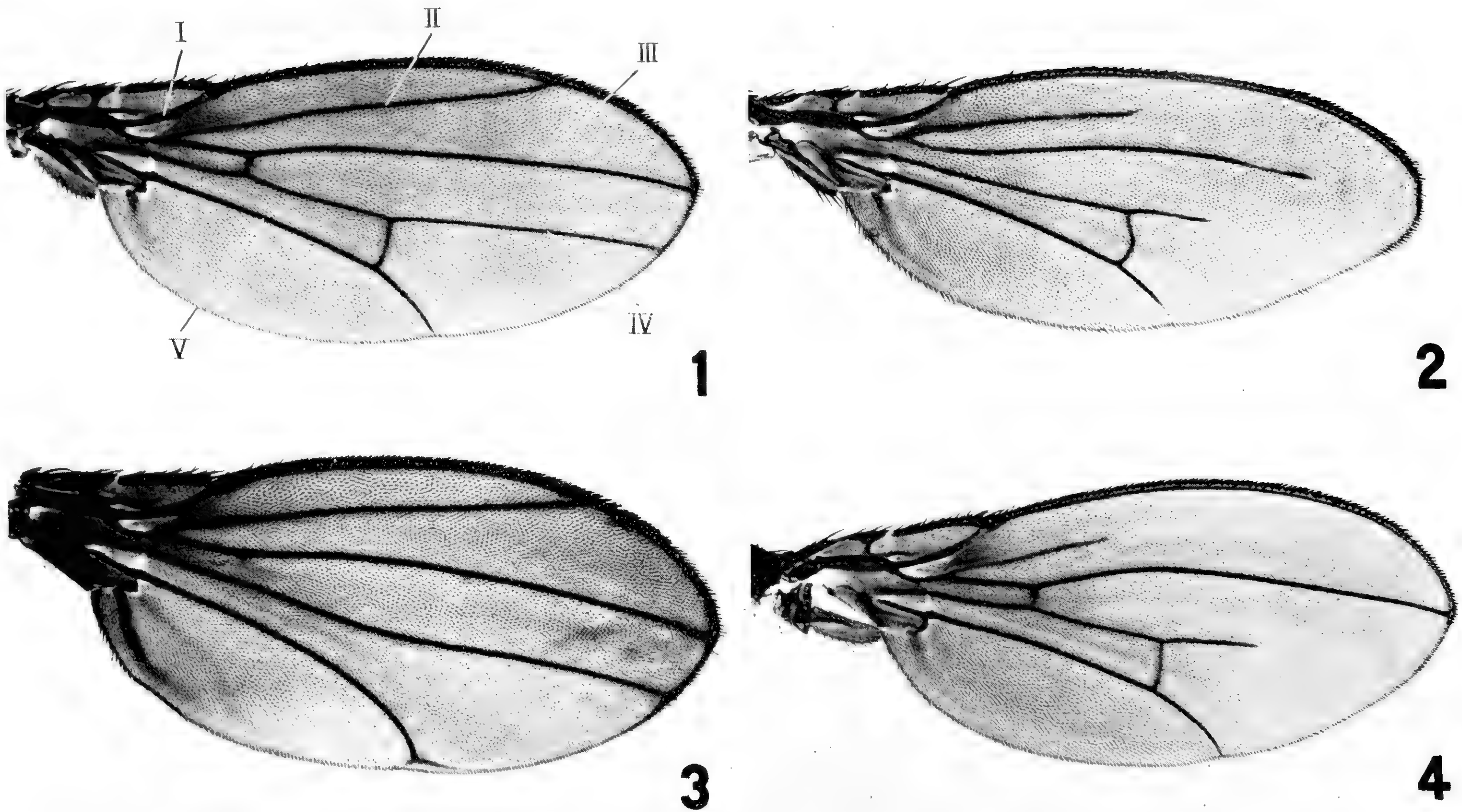
Intensive study of twinning would seem justified by the recognized interest of human twins as our most familiar evidence of the power of heredity to determine all of the characters in advance of development. The facts show that twinning is not a simple phenomenon, or merely an extra division of the fertilized egg cell, but involves a change of developmental behavior in groups of cells. The groups not only subdivide and separate but regenerate. The program of development is reorganized in relation to new median lines or planes of symmetry, so that two individuals are developed. As a result of twinning, cells from the median parts of the undivided group must become lateral, or regenerate lateral cells.

Totipotence, or genetic equality of the embryonic cells has, of course, to be assumed to account for the fact that the developmental functions of many of the cells are changed to accord with the revised plan of producing two individuals instead of one. The recognition of totipotence is an admission of the fact that the courses of development can be changed, but totipotence alone does not account for changing the plan, or for the assignment of the new and highly coordinated parts that the cells must play in the drama of development. Characters are expressed in all of the stages of development, in the sequence that is proper to the successive stages. Definite differences may appear in juvenile or embryonic stages, as well as in the adult stage if expression is varied or abnormal.

Though the characters of the adult are determined by the behavior of the cells in development, yet the cell behavior itself apparently is determined by a form of control which has the power to regenerate and reorganize, which amounts to redetermining the expression of the characters. No idea of such a directing or determining agency is afforded by current conceptions of heredity as a complex of independent Mendelizing "characters." The evidence that such changes of development as are involved in twinning can be initiated or induced by environmental causes, while the same plan or pattern of development is carried out with such exactness as twins often show, should be of interest to every student of heredity.

For some purposes twinning may be considered as a very slight form of abnormality, though connected by scarcely perceptible degrees with many more definite abnormalities. The forms of control and the nature of the adjustments that are required for the processes of normal heredity are shown most effectively in contrast with defects or disturbances of the normal course of development. The ability to resist adverse conditions of the environment and maintain a normal course of development is an important "character," or aspect of heredity. The best reason for the study of abnormal forms is to gain a better understanding of normal heredity. Monstrosities and malformations have been recorded extensively, but little use can be made of such facts for purposes of instruction until they are somewhat organized and interpreted, as many are in the present work.

O. F. Cook.



NORMAL WINGS AND WINGS OF THREE SEX LINKED MUTATIONS

FIGURE 15. Number 1 shows the normal form of the wing in *Drosophila willistoni.* The five longitudinal veins are numbered for convenience in comparison. Number 2 shows the form of the wing in the mutant race called *abbreviated,* in which three of the veins do not reach the margin of the wing. The *crossveinless* mutant is shown in Number 3. Notice the branched ending of the fifth vein—characteristic of this form. Two distinct abnormalities are shown in Number 4: *interrupted,* involving the loss of part of the fourth vein at or near the apex; and *stump,* which affects the second vein in much the same way, although more of the vein is lost.

ADDITIONAL MUTANT CHARACTERS IN DROSOPHILA WILLISTONI

Ruth M. Ferry, Rebecca C. Lancefield and Charles W. Metz
Department of Genetics, Carnegie Institution of Washington

TWENTY-EIGHT of the sex-linked characters in *Drosophila Willistoni*, Sturt., have been described in an earlier paper by Lancefield and Metz.[9]* The present paper includes descriptions of six additional sex-linked characters and twenty-three autosomal characters in this species. Accompanying each description is an account of the origin of the character and a comparison with similar characters in other species, wherever such characters are known. The linkage data, and a comparison of the genetic behavior of the characters with that of characters in other species, will be considered in a subsequent paper.

A list of the characters together with a brief statement as to their origin and nature are given in Table I. In this table the characters are arranged chronologically. In the subsequent descriptions the arrangement is chronological within the respective linkage groups, and in the section on characters not yet "placed."

The present mutant characters as well as those previously described have all arisen in a single line of flies derived originally from Cuba. Since the species does not occur in the United States, save rarely in Florida or adjacent regions, it is practically certain that no contamination of the stocks from outside sources has occurred.†

We are indebted to Miss E. M. Wallace for making the drawing of tardigrade, and to Miss E. M. Lord for assistance in making the accompanying photographs, and also for the other drawings.

Sex-Linked Characters

Interrupted (i)
Figure 15, No. 4

Description.—Interrupted is a variable character distinguished by a break in the fourth vein of the wing, involving the loss of a small section at or near the apex. The character is partially sex-limited, appearing fairly regularly in the females, but only occasionally in the males.

Origin.—(W1214). One male was found in a mating for short.

Bald (bd).
Figure 19

Description.—The bristles and hairs on the head are either very small, or entirely missing, in bald. One or all of the dorso-central bristles may be missing and the hairs on the thorax are more sparse than usual and the rows are irregular. Sometimes one, or both, of the anterior scutellar bristles may be small or missing entirely. The most constant characteristic of bald is its effect on the head bristles and hairs.

Origin.—(R789). One male was found in rounded stock.

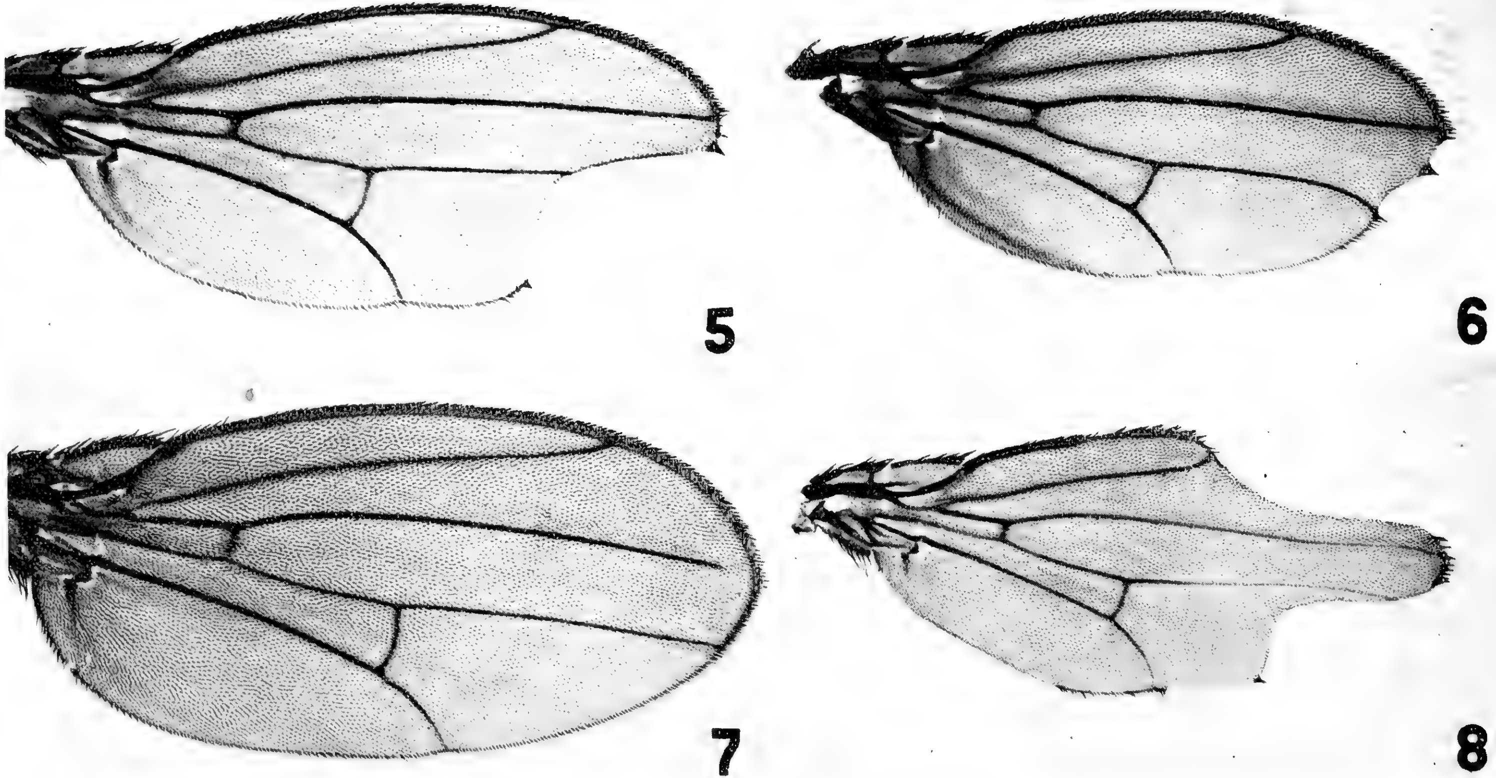
Vermilion (v).

Description.—Vermilion affects the color of the eyes, causing them to be a lighter and brighter red than usual. The black fleck in the center of the eye, characteristic of the normal condition, is missing in vermilion, and the ocelli are white rather than yellow.

Origin.—(R1074). One male was found among the offspring of a mating of blunt approximated by blistered.

*For Numbered References, see "Literature Cited" at end of article.

†Particular mention is made of this fact, only because the opinion is still held in some quarters (cf. Hagedoorn and Hagedoorn '22)[5] that *Drosophila* "mutants" may merely be segregates resulting from hybridization.



FOUR MUTANT WING CHARACTERS

FIGURE 16. *Clipped* (No. 5) and *Scalloped* (No. 6) are quite similar, and may be due to the same gene. They are both dominant characters. In *broken* (No. 7) the second, third and fourth veins, or any combination of these, fail to meet the margin of the wing. *Ragged* (No. 8) is characterized by a wing with an irregularly cut margin on each side of the tip. The marginal hairs of the remainder of the wing are disposed in bunches. The genes for *Clipped, Scalloped* and *ragged* are located in the second linkage group. *Broken* is a sex-linked character.

Comparison. — Vermilion resembles the character of the same name in *Drosophila melanogaster,*[9] *D. virilis,*[5] *D. obscura,*[4] and *D. hydei.*[3]

Abbreviated (ab).
Figure 15, No. 2

Description.—In abbreviated, the second, third, and fourth longitudinal veins fail to reach the margin of the wing, the second and the fourth being affected the most. Usually the anterior cross-vein is missing though this is not a constant characteristic. Occasionally one of the scutellar bristles is bent at right angles to the scutellum. The wing itself is more pointed and narrower than the normal wing.

Origin.—(R1453). Fixty-six males were found in the first hybrid generation of a mating of rough scalloped by blunt approximated.

Broken (bk).
Figure 16, No. 7

Description.—In broken, the second, third, or fourth veins, or any combination of these, fail to meet the margin. Pure stock has not yet been obtained, hence it is not certain that the character always manifests itself.

Origin.—(R1532). Seven yellow scute rough stump broken females were found in the second generation from a mating of vermilion by yellow scute rough stump.

Crossveinless (c).
Figure 15, No. 3

Description.—Crossveinless is characterized by the absence of the posterior cross-vein and usually of the anterior cross-vein also. A small part of the anterior cross-vein may be present as far as the sense organ. The fifth vein enlarges as it meets the margin of the wing like a delta. There is also a slight enlargement of the other longitudinal veins as they meet the marginal vein.

Origin.—(R1627). Several males were found in ragged stock.

Comparison.—Crossveinless resembles the crossveinless of *D. virilis*[11] and *D. melanogaster,*[1] except for the apical enlargement of the veins. The latter feature is sometimes seen in our stock of crossveinless in *D. virilis,* but not commonly.

Second Chromosome Characters

Approximated (a).
Figure 17, No. 10, and Figure 21

Description.—In approximated flies the two cross-veins of the wings are much closer together than in the wild-type flies. The legs are also greatly modified, the first tarsal joint of each leg being absent and the remaining ones shortened.

Origin.—(L88). About twenty males and females were found in a normal mass culture.

Comparison.—The wing modification involved in this character is seen in mutants of other species, but not, so far as we know, in company with the leg modifications found here.

Spread (sp).

Description.—In spread the wings are held at an angle of almost ninety degrees from the body and are curved down. In older flies, the wing is usually curled or torn along the margin and the tip is often gathered in.

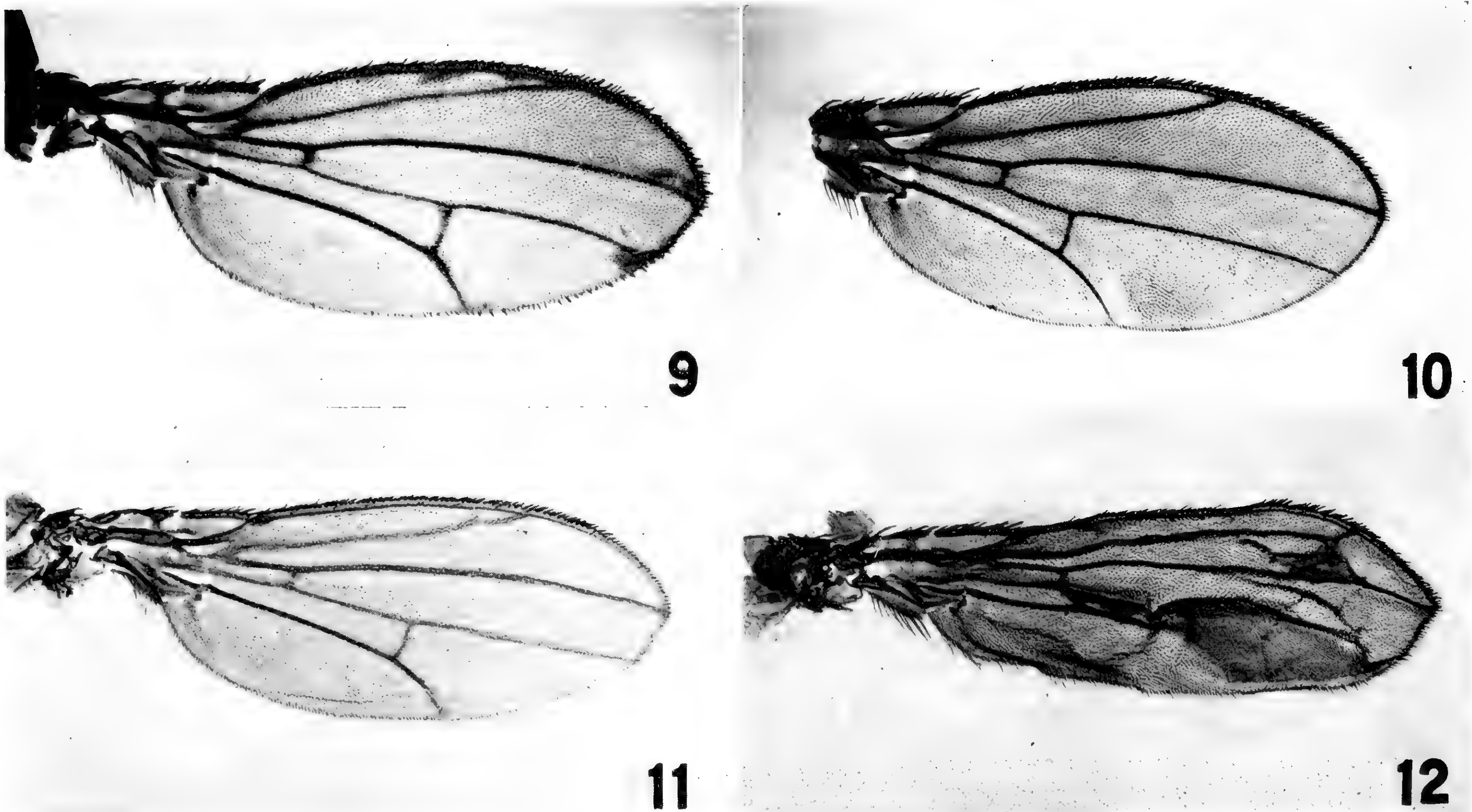
Origin.—(W18, W19). Two males and one female were found in a mating for sparse.

Comparison.—Spread resembles in a general way the numerous spread wing mutant characters of other species of *Drosophila,* but so far as we know none of the latter agrees with it in detail.

Blunt (b).
Figure 19

Description.—The scutellum is square instead of pointed in blunt. Usually one or both of the anterior scutellar bristles are missing, though all four scutellar bristles may be present, in which case the posterior ones are very much closer to the anterior ones than in the normal condition.

Origin.—(W13, W17). Blunt was found in the second generation of a mating involving approximated.



FOUR INHERITED ABNORMALITIES

FIGURE 17. In *Knotted* (No. 9) the veins are enlarged irregularly, especially where two of them join. The marginal hairs are in bunches; the tip of the wing may be cut off squarely, or it may be bent up. The character is a dominant and the flies have poor viability. The two cross-veins are much closer together in *approximated* (No. 10) than in the normal form, and the legs are greatly modified (see Figure 21). The wings of *granulated* (No. 11) are shiny but with blotchy coloring. The veins are thickened and some of the bristles on the body are affected. In *balloon* (No. 12) there is a network of extra veins between the second and third, and between the fourth and fifth veins. There is generally a broken bubble between the fourth and fifth veins.

Circular (cr).

Description.—The wings are circular, and often balloon shaped; and the entire fly is small. As it had very poor viability, it was difficult to breed and the stock has been lost.

Origin.—(W294). Several males and females were obtained from a mating for sex-ratio.

Knotted (K).

Figure 17, No. 9

Description.—Knotted affects all the veins of the wings. They are enlarged irregularly into knots, especially where they meet each other or meet the marginal vein. There may be extra veins present as branches from the main veins, and the cross-veins may be gone or may be close together, like approximated. The marginal hairs are present in clumps giving the edge of the wing a fringed appearance. The wing is sometimes cut off square at the tip or it may be turned up at the tip instead of lying down over the abdomen as the normal wing does. The wings also are often smaller than normal. The character is a dominant and the flies have poor viability.

Origin.—(W922, L581). One knotted male and one knotted female were found in the first generation of a mating of rough rosette by morula.

Comparison.—Knotted resembles delta in *D. simulans*[10] in having the first vein thickened; the second vein frequently thickened at the end, and sometimes throughout the whole vein; and the others sometimes thickened. Like delta it is an autosomal dominant, and the flies have poor viability. Knotted differs from delta in not having a branch on the posterior cross-vein; in not having the wing-margin cut or nicked; in not having sterile females; and in having normal bristles on the scutellum.

Clipped and Scalloped (Cl and Sl).

Figure 16, Nos. 5 and 6

Description of Clipped.—Clipped is a dominant character, distinguished by variable incisions on the inner margin of the wing as shown in Figure 16. Presumably the gene is lethal when in the homozygous condition, for matings of clipped by clipped give approximately a 2:1 ratio, and selection (in keeping stock) for forty-four generations has failed to give a homozygous stock.

Origin of Clipped.—(W1828). Many males and females were found in a mating of rough by scute short-3.

Description of Scalloped.—The character scalloped agrees in all respects with clipped and is probably due to the same gene (or an allelomorph), although this assumption has not yet been tested adequately.

Origin of Scalloped.—(W1854). Many males and females were found in a mating of rough by scute short-3.

Apterous (ap).

Description.—Apterous is characterized by the entire absence of wings, by greatly reduced balancers, by the square rather than pointed scutellum, and by the absence of scutellar bristles (in most cases). In addition, the thorax is sometimes greatly deformed. Since both sexes are sterile the character is very difficult to keep in stock.

Origin.—(R64). Several females were found in the rough clipped stock. Later a few were found in the rough scalloped stock.

Comparison.—Apterous flies have been found in other species of *Drosophila* (e. g., *D. melanogaster*[7]) but the difficulties of breeding have made detailed linkage studies impracticable, and comparisons may be omitted here.

Ragged (rg).

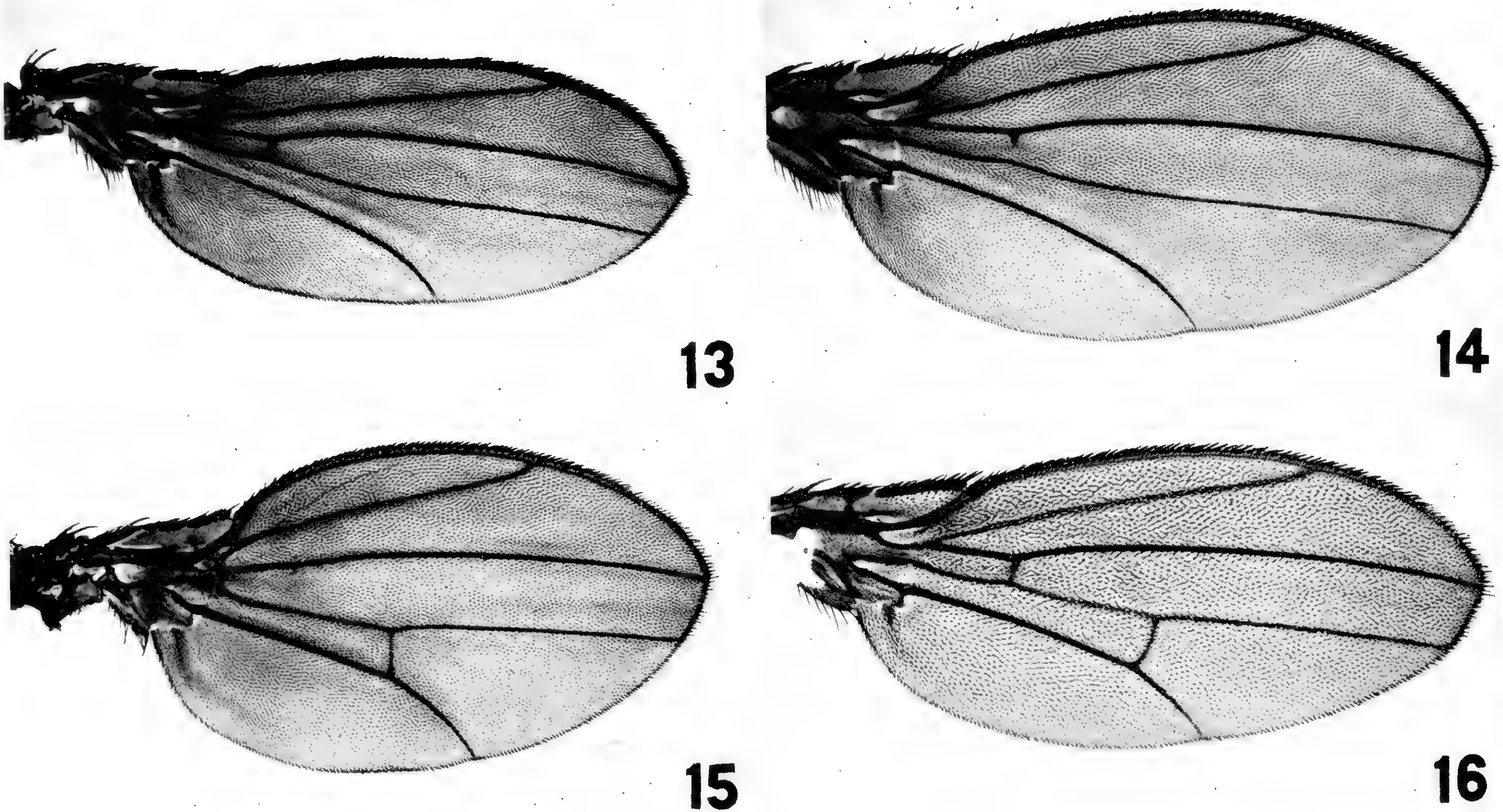
Figure 16, No. 8

Description.—The margin of the wing is cut irregularly on each side of the tip and the marginal hairs are present in clumps along the part of the edge which has not been cut.

Origin.—(R1155). Several males and females were found in a heterozygous stock carrying combined.

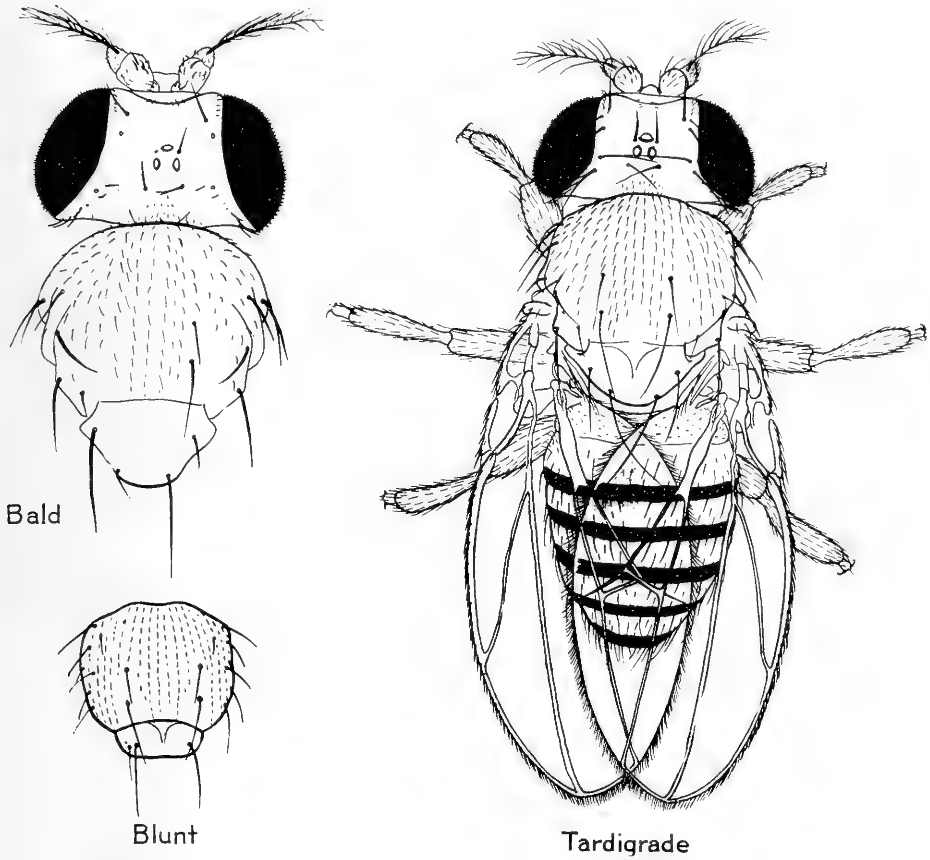
Red (red)

Description.—Red is an eye color character. The eye is a darker and



CHARACTERS IN THE THIRD LINKAGE GROUP

FIGURE 18. In the mutant race called *absent* (No. 13) both cross veins may be missing, or only the posterior one, as shown here. *Incomplete* (No. 14) resembles *crossveinless* (Figure 1), but this is an autosomal character (not located in the sex-chromosome) while *crossveinless* is a sex-linked character. In *rounded* (No. 15), the wing is shorter and broader than usual, and one or both cross veins may be lacking. *Blistered* (No. 16) affects eyes and bristles as well as the wings. The hairs on the surface of the wing are arranged irregularly, giving it a roughened appearance.



MUTANT CHARACTERS OF HEAD, SCUTELLUM AND WINGS

FIGURE 19. In *tardigrade* flies, four of the tarsi (last five joints of the leg) are missing. (See Figure 20, where this is shown in connection with another character.) The anterior cross vein is missing and the fourth and fifth veins are connected by an extra cross vein at the base. In *bald,* some of the bristles are missing from the head and from other parts of the body. This is a sex-linked character. In *blunt* the scutellum is cut off squarely instead of being rounded at the posterior end, and some of the bristles are absent.

duller red than that of the wild-type fly and the conspicuous dark fleck of the latter is absent or faint.

Origin.—(R1501). Many males were obtained from a mating of bald by scute rough stump. This character had apparently been in scute rough stump stock, but had not been detected owing to the presence of rough.

Comparison.—Red might be compared with various dark eye colors of other species, but in the absence of associated characters there is little evidence to indicate homology with any of these.

Balloon (bo).

Figure 17, No. 12

Description.—In balloon, the wings have a network of extra veins between the second and third, and the fourth and fifth veins. There is also an extra vein between the second and the marginal vein and sometimes the second and the third veins are fused together instead of having the anterior cross-vein present. There is usually a broken bubble present in the network

NORMAL AND VARIANT LEGS

FIGURE 20. Above are shown the front, middle, and hind legs from the right side of a normal fly. Below are shown the legs of a mutant from called *combined,* in which four of the tarsi are absent, the one to which the claw is attached being all that is left. This fly looks about as peculiar as would a man if his hands were attached at the elbows and his feet at the knees. Other deformities also characterize the mutation.

of extra veins between the fourth and fifth veins. Generally the texture of the wing is heavy and muddy in appearance.

Origin.—(R1707). Several males and females were found in rough scalloped stock.

Comparison.—Balloon agrees closely with the description of balloon in *D. melanogaster* given by Bridges and Morgan,[2] but the stocks have not as yet been compared.

Third Chromosome Characters

Tardigrade (*td*).

Figure 19

Description.—Four tarsi are gone in tardigrade just as in combined. The anterior cross-vein is usually missing, and the fourth and fifth veins are fused or connected by an extra cross-vein at the base. Tardigrade flies had poor viability and were very hard to breed, hence the stock was discarded.

TWO MUTANT CHARACTERS AFFECTING THE LEGS

FIGURE 21. Above are shown the three legs from the right side of the *cone* mutant. The first tarsus is shortened and thickened, giving it a cone shape, and the other tarsi are shorter than normal. Below are the three right legs of a fly showing the character *approximated.* The first tarsal joint of each is absent, and the others are shortened. This character also affects the wings (see Figure 17). It is maintained by some that the Drosophila "mutants" are nothing but segregates resulting from hybridization. This hypothesis is ruled out in the present case, as *D. Willistoni* occurs wild in Cuba, but is found no farther north than Florida. The stock used here has been inbred for over 200 generations and throws mutants as frequently as ever.

Origin.—(W1256, L374). Thirty-two males and females were found in an F_1 pair mating involving approximated.

Combined (co).
Figure 20

Description.—The anterior dorso-central bristles are missing; the groove between the thorax and scutellum is generally gone; and the tarsi are completely absent except for the segment to which the claw is joined. The fly breeds very poorly so that stock must be kept by using heterozygous flies.

Origin.—(W276). Two males were found in a mass culture.

Glossy (g).

Description.—The eye is very shiny as though varnished and has a black horizontal streak running through the center. The facets of the eye are irregular and more or less run together, giving the eye a roughened appearance. The flies have poor viability.

Origin.—(W716). Several males and females were found in a mating of blunt approximated by blunt spread.

Incomplete (ic).
Figure 18, No. 14

Description.—In flies of this race both cross-veins are missing, or practically so, although a piece of either one or both may be present.

Origin.—(W3079). Several males were found in forked-2 stock.

Blistered (bl).
Figure 18, No. 16

Description.—The eyes of blistered flies are lens-shaped and the facets are irregular and are sometimes yellow, so that the whole eye has a blistered appearance. One or more of the dorso-central and scutellar bristles may be missing; the wings have a shiny and roughened appearance due to the irregularity of the hairs on the wing (Fig. 18); the veins are somewhat thickened and the costal hairs are also slightly irregular. The flies have poor viability.

Origin.—(W1439). A blistered stump female was found in the stock of forked rough stump.

Rounded (rd).
Figure 18, No. 15

Description.—The wings in this race are shorter and broader than normal, thus giving them a rounded appearance. The anterior cross-vein is usually missing. When it is present, the two cross-veins are nearer together than normal, due to the shortening of the wing. Both anterior and posterior cross-veins may be lacking, in which case the wing is shorter than the abdomen and is curled up from the body. The origin of the veins is often indistinct.

Origin.—(R390). Many males and females were found in a heterozygous stock carrying combined.

Absent (as).
Figure 18, No. 13

Description.—In this mutant race the posterior cross-vein is uniformly absent and the anterior one may be gone, although it is usually present. The bristles on the thorax and scutellum are often curly, and sometimes a few of the tarsi of the hind legs are swollen.

Origin.—(R1119). Three males were found in rough scalloped stock.

Granulated (gr).
Figure 17, No. 11

Description.—The wings are very shiny, but with blotchy coloring. The veins are thickened irregularly. Some of the bristles, usually the anterior dorso-centrals, are missing from the thorax, and occasionally one of the scutellars is gone. In extreme cases, one or all of the bristles and hairs are gone from the head. Also the wings are smaller than normal and the eyes may be slightly roughened. The flies have poor viability.

Origin.—(R1953). Two males and one female were found in the second generation of a mating of blunt spread by ragged.

Characters Not Yet "Placed"

The following mutant characters are known to be inherited, but their linkage relations have not yet been worked out. With the possible exception of broken, they are all autosomal characters.

Branched (br).

Description.—The usual manifestation of the character branched is a short branch running distally from the posterior cross-vein at or near its junction with the fifth vein, or a branch from the fifth vein toward the margin. All the veins are slightly thicker than usual. The character is unsatisfactory to work with, for it seldom appears in the males and it does not always appear in the females.

Origin.—(R323). One female was found in triple stock.

Lacking (l).

Description. — Lacking is distinguished by the absence of one or both of the posterior scutellar bristles, but the character is not constant and sometimes fails to be manifest.

Origin.—(R606). Several males and females were found in the second generation of a mating for small bristles.

Cone (cn).

Figure 21

Description.—The first tarsus is shortened and broadened at its base giving it a cone shape. The other tarsi are also shortened. This condition is most extreme on the hind legs, but it is also seen to a lesser degree on the other two pairs. The wings may be bent down over the abdomen, although this is not a constant characteristic. Since cone males are sterile, pure stock cannot be maintained.

Origin.—(R2011). One male was found in the third generation from a mating of blunt approximated by rough clipped.

Jaunty (j).

Description.—In jaunty flies the wings are of a very thick and opaque texture and turn up at the tip. Generally the wings do not entirely unfold.

Origin.—(R2128). Several yellow scute jaunty females were obtained from the first generation of a mating of rough rimmed stump by yellow scute.

Comparison.—Jaunty bears a general resemblance to jaunty and the jaunty-like characters in *D. melanogaster*,[2] but it cannot be identified with any particular one at present.

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Chronological List of Sex-Linked Characters in Drosophila Willistoni

Character	*Symbol*	*Parts affected*	*First Observed*	*Found by*	*Record*
Interrupted	*i*	Wing veins	March 1920	R. C. Lancefield	W1214
Bald	*bd*	Bristles and hairs	May 1922	R. M. Ferry	R789
Vermilion	*v*	Eye-color	June 1922	R. M. Ferry	R1074
Abbreviated	*ab*	Wing veins	Aug. 1922	R. M. Ferry	R1453
Broken	*bk*	Wing veins	Sept. 1922	R. M. Ferry	R1532
Crossveinless	*c*	Wing veins	Oct. 1922	C. W. Metz	R1627

Chronological List of Autosomal Characters in Drosophila Willistoni

Character	*Symbol*	*Parts affected*	*Linkage group*	*First Observed*	*Found by*	*Record*
Approximated	*a*	Wing veins and legs	II	Apr. 1919	C. W. Metz	L88
Spread	*sp*	Wings	II	May 1919	D. E. Lancefield	W18, W19
Blunt	*b*	Scutellum	II	July 1919	D. E. Lancefield	W13, W17
Tardigrade	*td*	Wing veins and legs	III	Aug. 1919	C. W. Metz	L394, W1256
Circular	*cr*	Wings	II	Nov. 1919	R. C. Lancefield	W294
Combined	*co*	Legs	III	Nov. 1919	R. C. Lancefield	W276
Knotted	*K*	Wings	II	Dec. 1919	R. C. Lancefield	W922, L581
Glossy	*g*	Eyes	III	Jan. 1920	R. C. Lancefield	W716
Incomplete	*ic*	Wing veins	III	Feb. 1920	R. C. Lancefield	W3079
Blistered	*bl*	Eyes, wings and bristles	III	May 1920	R. C. Lancefield	W1439
Clipped	*Cl*	Wings	II	Aug. 1920	R. C. Lancefield	W1828
Scalloped	*Sl*	Wings	II	Aug. 1920	R. C. Lancefield	W1854
Apterous	*ap*	Wings, scutellum, bristles, thorax	II	Nov. 1921	R. M. Ferry	R64
Branched	*br*	Wing veins	?	Feb. 1922	R. M. Ferry	R323
Rounded	*rd*	Wings	III	Feb. 1922	R. M. Ferry	R390
Lacking	*l*	Bristles	?	Mar. 1922	R. M. Ferry	R606
Absent	*as*	Wing veins	III	July 1922	R. M. Ferry	R1119
Ragged	*rg*	Wing	II	July 1922	R. M. Ferry	R1155
Red	*red*	Eye-color	II	Aug. 1922	R. M. Ferry	R1501
Balloon	*bo*	Wings	II	Nov. 1922	R. M. Ferry	R1707
Granulated	*gr*	Wings	III	Dec. 1922	R. M. Ferry	R1953
Cone	*cn*	Wings and legs	?	Jan. 1923	R. M. Ferry	R2011
Jaunty	*j*	Wings	?	Feb. 1923	R. M. Ferry	R2128

Racial Origin of Gregor Mendel

Before the war, the founder of Mendelism was usually referred to as "the Austrian monk." Following the dissolution of the old monarchy, and the constitution of the Czecho-Slovakia, I have seen him mentioned as a Czecho-Slovak. Little is known of his pedigree, and few writers have paid any attention to it. A comment on this, in a correspondence with Professor Fritz Lenz of the University of Munich, drew forth the following interesting opinion:

"If Mendel is now being claimed for Czecho-Slovakia that is another 'imperialistic annexation' which, like so many others, does not correspond to the 'self-determination of peoples.' Mendel was throughout of German origin, of a family believed to have emigrated from Bavaria. Racially, he was a mixed type, presumablyy a blend of nordic-alpine-dinaric, like most of the population of that region. He was certainly not pure Alpine in race, nor a Slav in nationality."—*P. P.*

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DEFECTIVE CHILDREN ASCRIBED TO BAD ENVIRONMENT

The girl at the left was born before her parents left their home in Italy, and is a happy and normal child. The two microcephalic boys were born after the family had lived in New York. Dr. Schlapp has observed hundreds of such families, that have come to America with one or more normal children, but whose first children born in this country, where their parents were living under congested city conditions in New York, were defective. Later children of the same families are likely to be normal. Dr. Schlapp maintains that the defectives are the result of an alien and unnatural environment that disturbs the balance of the endocrine secretions of the mother. If the modern industrial city is an environment so ill suited to the people living in it that such effects can be induced, the facts need to be known. The mothers of the definitely defective children usually suffer severely from homesickness or other emotional disturbances, but it is believed that children who are not reckoned as defectives may fall below normal heredity as a result of the adverse conditions of urban existence. Support and care of defectives and deficients is becoming one of the great burdens of civilization, and is rapidly growing heavier. If these unfortunates represent only the extremes of a general deterioration that is going on, the outlook for progress under urban conditions is indeed somber.—*Editor.* (Frontispiece.)

CAUSES OF DEFECTIVE CHILDREN

Prenatal Development Affected by Glandular Disturbances in the Mother—Induced by Unfavorable Environment

MAX G. SCHLAPP

Professor of Neuropathology in Post-Graduate Medical School and Hospital. Director of Children's Court Clinic, New York City.

(Photographs copyrighted by the Author.)

RECENT studies of mentally defective children and their mothers have served to emphasize the fact that prenatal pathological conditions in the female parent are responsible for certain definite malformations in the child. These investigations have thrown light upon the causation of many obscure defects and deformities. More specifically, they have proved, for the first time, that to certain chemical imbalance in the blood of the mother can be traced the cause of many of the strange, monstrous unfortunates who have been born into the world and of whose peculiarities history has defied any explanation outside the realm of superstition.

For some years we have understood, from laboratory experiments on lower animals, that the introduction of extrinsic poisons into the female parent will bring about weaknesses, abnormalities and monstrosities in the offspring. Notably is this the case where the parent has been subjected to the toxic effects of morphine, alcohol or the like. But it is only now that we are beginning to realize that internal factors having to do with disturbances of the ductless glands are the chief causes of these mysterious malformations in children. Indeed, such malformations have heretofore been particularly baffling in view of the fact that the parents were, in many cases, apparently healthy individuals who revealed none of the stigmata so badly evident in the progeny.

At this point the reservation must be noted that intrinsic toxins, such as result from focal infections and infectious diseases, play a subordinate part in the prenatal history of the misbegotten. This part is, however, secondary as well as subordinate, the toxin most likely acting primarily upon the endocrine organs of the mother, which in the resulting pathological condition, fail to do their part in the development of the child.

With the number of mental defectives and deficients steadily mounting, the economic situation ever becoming more inimical to all weaker individuals, and the burden of public charity straining the state purse, locating the source of supply of the mentally handicapped becomes of vital importance, not only medically, but socially. An understanding of the profound causes of these conditions alone holds out the promise of their treatment and correction; namely, decreasing the begetting of these individuals and the certainty that many of them, notably the cretins, can be normalized after birth must be welcomed as an addition of the first rank to the sum of our medical and social progress.

The Causes of Abnormal Development

To understand the etiology, or the general and specific causes of such disturbances as are responsible for the birth of mental defectives, we must go back to the life processes of those fundamental organisms, the living cells. Of these processes there are only three: the nutritive, the formative and the functional. The nutritive process

is that activity by which the cell takes into itself nutriment from the surrounding medium (as in the case of the amoeba living in the sea water), and stores this food as potential energy. The formative process is commonly called cell division. It is the process by which organisms grow, and it is with this matter of growth that we shall have most to deal in this connection. The functional process—which does not especially concern us now—is the part of all life that is devoted to some specific activity, such as the contraction of a muscle cell, the secretion of a gland cell, the impulse transmission by a nerve cell or the simple locomotive movements of an amoeba.

Thus, like all living creatures, the cells which make up the body engage in three principal activities: feeding or absorbing energy, growing or reproducing, and functioning or performing some special act or labor in which the stored energies are consumed. It would seem a platitude to say that if a human being is fed on bad food he will sicken and will be able neither to grow nor to work, but it is stating a fact as yet not generally recognized to apply this bit of common sense to the cells of which that human being is made. Particularly does it seem almost startling to apply it to the cells of the unborn child.

Just here lies the core of our problem. The formative process of the cells in the human embryo is dependent upon a chemically normal medium—a healthy blood condition in the mother. Expressed in the simplest terms, this process must have a well balanced ration of food peculiar to it. If this condition prevails, and there has been no serious involvement of the germ plasm, the various groups of cells in the foetus will develop normally and we shall have—other troubles not intervening—a healthy child. We know, however, that toxins of all sorts act selectively on special cell groups, inhibiting or exaggerating their growth. Thus the presence in the mother of any kind of extrinsic or intrinsic poisons may cause the development of monsters. The same rule is now known to apply in any case where the chemical medium on which the growing cell feeds is seriously disturbed by abnormal functioning of the internal secretory glands.

A parallel is to be found in primitive marine life. Not only are the simple organisms that float in the littoral waters of the sea killed or injured by the presence of hostile chemicals, but also by variations in the salt content or the temperature of the brine. The medium upon which the human embryonic cell feeds and in which it lives is precisely comparable to the amoeba's sea water. If the endocrine balance of the mother becomes disturbed from any cause, such as worry, strain, emotional shocks, grief, fright, constant excitement and the like, during the course of the gestation period, there is the gravest likelihood that the chemical balance of her blood will be deranged, that certain cells which live in it and feed on it will grow abnormally or refuse to grow at all, and that another defective will be born.

Typical Cases

Case 1. A family of Italian peasants was attracted to America because one of the neighbors had returned to the home village in what seemed a golden prosperity. This man had gone to America ten years before and, after the usual struggles and defeats, had prospered in a small way. In his new felicity he forgot his early trials and told only of triumphs. The peasant family sold what it owned, hopefully packed a few belongings and set out from that peaceful, normal environment in which the stock had grown from the time of the Caesars, to stake its small strength against the industrial giant, yawning across the sea. Of these wayfarers there were only three, the parents and one daughter, a happy and normal child. (See Frontispiece.)

These strangers settled in New York. Their poverty was pitiful; their

struggle to adjust to a totally alien environment worse than brutal. The mother was forced out into the economic fight. At about the same time she became pregnant with the second child. That rest, that repose which all women need for the labors of child creation, was denied her. Instead of the cool mornings, the hot days and the long purple evenings of her Ligurian hills, she had the drudgery of a mill for her ease. Naturally, she was seized with a powerful nostalgia. Her home and her past beckoned her out of the inferno into which she had wandered. Outwardly, the miserable woman's emotions cooked over into constant tears. Inwardly, they seethed up into a very grave disturbance of the endocrines. In this condition she struggled through the forming and bearing of the second child, and then of the third. At length, something of the measureless tragedy of her situation weighed upon her, and she came to the clinic with her microcephalic children—idiots. (Again see Frontispiece.)

It was impossible to induce this mother to submit herself to the various metabolism tests, but even outwardly she gave unmistakable evidences of a disturbed metabolism due to chemical imbalance. She was not, however, in the least microcephalic. And it will be well, at this point, to accentuate the fact that mothers of microcephalic children rarely, if ever, show any of the faults of their unhappy progeny. Our problem, in these cases, is apparently one of prenatal chemistry, not of heredity. If these pathological types were to breed, no doubt many of the cases would reproduce a similar defect. In other words, we have here possibly a mutation. These cases, however, being so defeective, there is no possibility of their breeding. How many such defects may be continued by heredity after once having been established by serious environmental changes is not known, although Stockard, of Cornell, has shown that malformation produced in the offspring by extrinsic toxins being introduced into the parent can be lost in three or four generations and the animal returned to the normal condition. If the pathological change in the offspring of a disturbed mother is slight enough not to inhibit reproduction, it may very readily be continued for a number of generations. This mother showed symptoms indicative of constitutional imbalance caused by endocrine disorder, such as depression, intense restlessness, insomnia, loss of appetite and of weight, tremors, profuse perspiration, palpitation of the heart, and so forth.

Case 2. We have here an American-born mother of four children, all of them born within five years. (See Figure 1.) It will be seen that the first and the second children are perfectly normal. The third child followed fast upon the two earlier ones, and, to make matters worse, the mother, in the first month of pregnancy with this child, contracted influenza and was in bed for three or four weeks. After the illness she was unable to recover her strength, and in this depleted state of her forces she passed through the remainder of the child-bearing period. The fruit of this set of circumstances is, as may be seen, a typical Mongolian idiot.

The mother could not nurse the child, but after some months she recovered strength rapidly, and within fifteen months after the birth of the third child she brought the fourth child into the world. This infant gave all the normal responses and is apparently healthy.

Mongolian Idiocy Due to Endocrine Disturbance

It is, of course, well known that the Mongolian type of idiot is commonly the child of a mother who is nearing the menopause. At this period of a woman's life the hormone balance is seriously disturbed. From my own observations and those of many others, it is now safe to conclude that Mongolian idiots are also frequently born of younger women whose endocrines have been disturbed by the drain of in-

MONGOLIAN IDIOCY DUE TO UNBALANCED HORMONES

FIGURE 1. It has long been a matter of observation, recently confirmed by statistical studies, that Mongolian idiots are in the great majority of cases the children of women nearing the menopause, a period when the harmone balance is known to be disturbed. This type of defective children is also born of mothers who have had the normal secretion of their ductless glands upset by the drain of infectious diseases, or from other causes. In this case the mother contracted influenza about eight months before the birth of the third child who is a Mongolian idiot. The three other children are apparently normal, their startled appearance is due to being photographed by flashlight.

fectious diseases or other causes, such as emotional strain, exposure to industrialism, and so forth.

Since Mongolian idiots are invariably alike, it is to be deduced that a uniform type of disturbance is responsible for them. And, since we know that such an offspring is borne most frequently by women suffering from endocrine disturbance common to the pre-menopause state, we may safely conclude that the misbirth in this case (Figure 1), was not directly due to any of the intrinsic toxins of the influenza from which the mother had suffered, but that its causation was of secondary nature. That is to say, that the peculiar type of abnormality of the child may be accepted as convincing evidence of a condition in the mother analogous to the endocrine disturbance in the women who are most frequently the mothers of this type of child.

Effect of Environment on Type of Children

Going back to Case No. 1, it is important to note that, in my own clinic

at the Post-Graduate Medical School and Hospital, *we have recorded hundreds of cases* in which immigrant couples who had produced normal children in Europe, under familiar environment, have, after their arrival in this country and their projection into the unfamiliar and enervating social and economic situation, brought forth one, two and in rare instances more defectives.

It seems to me that there can be no question that the emotional nature of man, and particularly of woman, plays an important part in bringing about the chemical disturbance which is responsible for such abnormalities. The homesickness of these mothers is always marked, and this is the beginning of a general emotional involvement. Strangely, and yet naturally enough, after four or five years, when the immigrants have become adjusted to their new environment, they bring forth healthy children again.

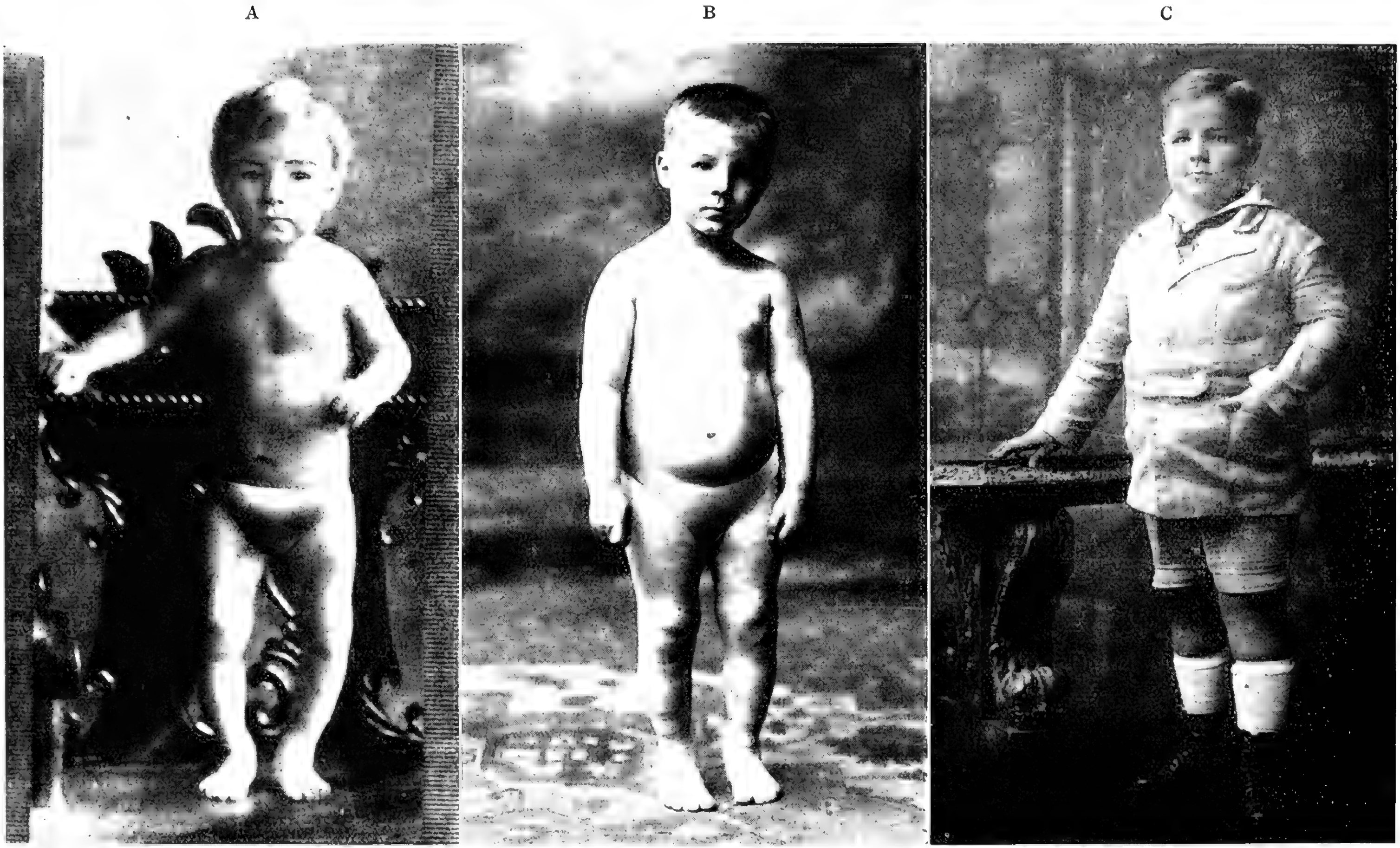
In the case of Mongolians and microcephals, the endocrine disturbance in the mother has evidently been grave, resulting in a serious derangement of the formative process of the cells in the child. Unhappily, in the present state of our knowledge we are unable to treat such children successfully. But in all probability we could prevent the occurrence of these abnormalities in children of previously healthy young mothers, if the normal chemical balance of the mother could be restored by treatment before the conception of the children. Not only are we unable to help such children materially, but we do not know precisely what glands of the mother or of the child are involved. We have the suspicion of a pluriglandular involvement, and this notion is sustained to some extent by the fact that such cases have been kept under pluri-glandular treatment for periods of from eight to ten years and good results have been secured, without, however, having been able to achieve normality. The well-known short-livedness of such seriously defective individuals and their great susceptibility to infectious diseases would also seem to support this idea.

It will be seen from both the above cases that strains and drains on women are and must be responsible for the birth of many inferior children. How slight or how grave the inferiority may be will depend, of course, upon the degree to which the mother has been impoverished or harmed.

Women in Industry and Business

Nothing is more certain than that woman is especially adapted by nature to the anabolic process of storing up energy to be used in the function of child creation and nourishing. It is obvious that if this energy, instead of being used for the process for which it was designed, be diverted to another process, the organs which were created for and adapted to the original process will undergo a change comparable to rust. That is, they will no longer be able to perform their special task as easily or as successfully as if the energy supplied to them had never been diverted to perform other tasks of a different nature. Now, when the supply of energy which nature has prepared for the biologic function in a woman is not disposed of through the means provided, but is applied to the performance of other tasks, this woman naturally becomes less and less able to bear healthy, normal children. Under modern social and economic conditions increasing numbers of women are expending the energy intended to be reserved for their vital function in what was formerly considered man's work. It is only natural that such women are likely to bear poor children and thus to add materially to the afflictions of society.

But the problem is not merely one of the mothers' misspent energies and exhausted forces. The emotional side of a woman's life is quite as important a factor in this connection as the physical side. The constant shocks to which a woman is subjected in industrial and business life have the effect of upsetting her glands and nervous system.



COMPLETELY NORMALIZED BY TREATMENT

FIGURE 2. At two years of age this child could not stand without being supported (A), and could not talk. After fifteen months of thyroid treatment he is well on his way toward being entirely normal (B). At eleven years of age he is an active and thoroughly normal boy—ahead of his grades at school (C). He is still taking treatment, and will have to do so at regular intervals throughout the rest of his life. He is suffering from a serious deficiency of the thyroid gland, and not from its entire absence, or treatment must have been begun much earlier to have succeeded.

We have already seen what results from such disturbances. It is a fact, well understood by all neurologists, that women are peculiarly sensitive to emotional stresses and to all manner of thrills, fears, and excitements. Woman is by nature more unstable than man. She is ill adapted to the struggle for subsistence and her projection into the vortex of industrial life is daily proving a more and more serious menace to the future of the race.

Successful Treatment of Defectives

Our failure to help such cases as the two described is, however, more than compensated by striking success in instances where the mother has been less gravely disturbed. The extent to which we have been able to normalize cretins and other thyroid cases has certainly not been the least marvel of modern medicine. These types of children form the majority among the offspring of mothers suffering from the milder forms of chemical imbalance of a certain kind. As is well understood, these children are of two types: (a) those in whom the thyroid gland is absent; and (b) those in whom it is undeveloped in varying degrees. In either of these instances it is apparent that the formative activity in the cells of the child has been selectively inhibited, only the thyroid being primarily involved. If the gland is absent, the case is, of course, most serious and early treatment is imperative. If such children can be taken in hand during their first year and the full cooperation of the parent secured to the end that the treatment be constant and continuous, we can now completely correct the conditions by the feeding of the required amounts of thyroid substance. In cases where the gland is merely deficient, good results can be secured even after the child has reached the age of two or three years.

Just here, however, a point of the utmost importance must be understood. Most parents, and, I believe, some doctors, labor under the misconception that endocrine material, prescribed in definite cases of bodily absence or deficiency, may be taken for a time and then discontinued. As a matter of fact, a child with an absent or deficient thyroid must take the required amounts of thyroid substance regularly and without fail for the rest of its life. The evil results of an opposite policy will be seen in Figure 5.

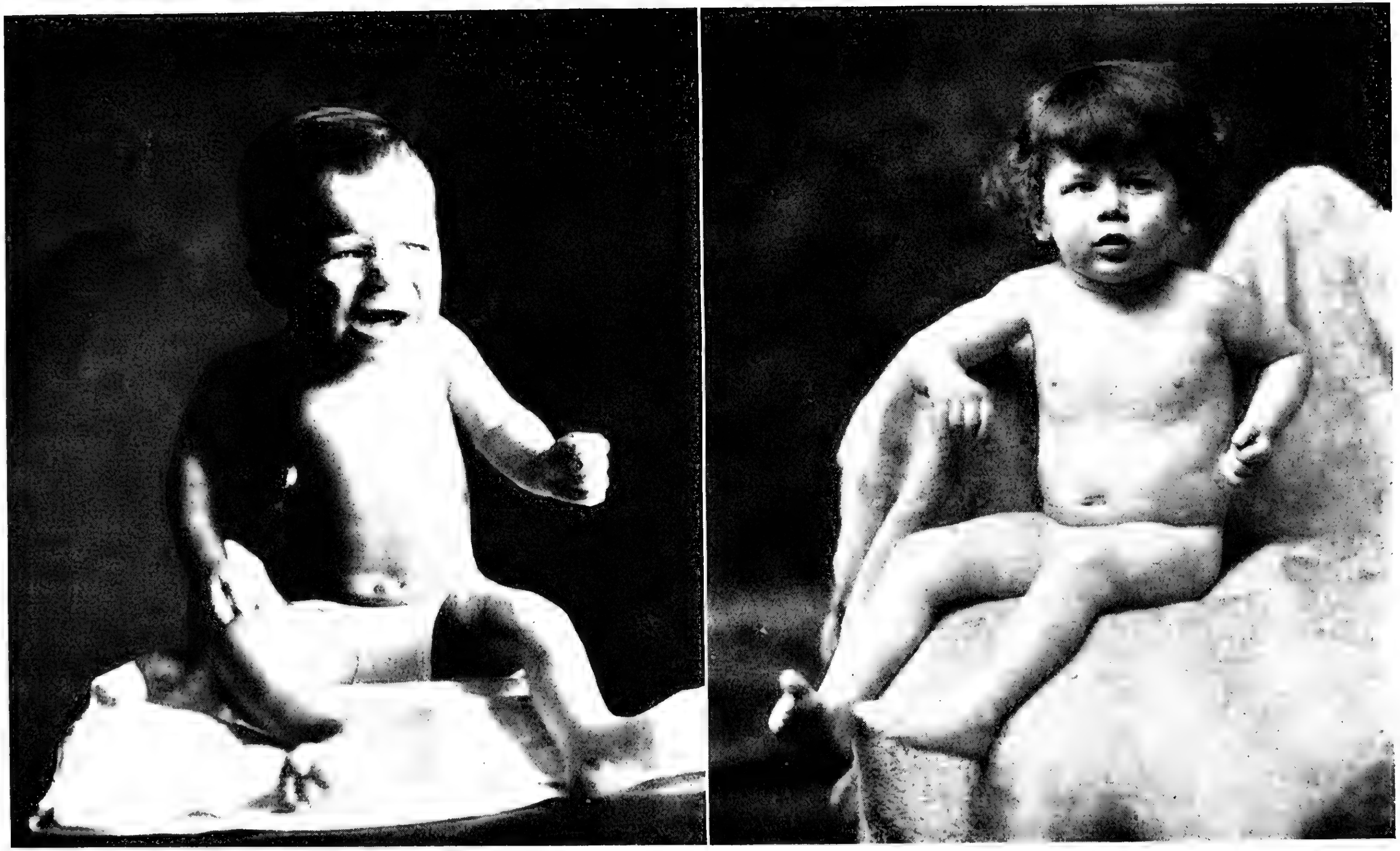
If there is a marked deficiency or total absence of thyroid hormone in a child, the growth of the body, particularly of the brain, bone structure and hair, will be inhibited and the result will be dwarfing, mental deficiency and monstrosity. (In thyroid cases the gonads are not so seriously affected as in cases where there is a deficiency of the anterior lobe of the pituitary.) Consequently, if this condition is not corrected early in life, parts of the brain will simply fail to form, and it is apparent that such lost ground cannot be regained. What has never formed cannot be treated. We cannot build brains. All we offer now is help toward their formation by the introduction of the missing endocrine materials which control their growth.

The happy results of early and consistent treatment of thyroid children will be seen from Figures 2 and 3.

Again in Figure 2, we see the pictorial history of a child suffering from a dangerous hypothyroidism. In Photograph A, we have the child at the age of two; in Photograph B, after fifteen months of treatment; in Photograph C, at the age of eleven years, thoroughly normalized, ahead of his grade in school, keen and active. This boy is, of course, still being treated and he will continue to be ministered to for life. Please note that he suffered from a marked deficiency, and not a total absence, of the gland. Had the latter been the case, he could not have been brought to such excellent health unless treatment had been begun much earlier than the age of two years.

In Figure 3, Photograph A, we have a cretinous child of six months, at which time treatment was begun. In Photograph B, we see the same child at two years, after consistent treatment.

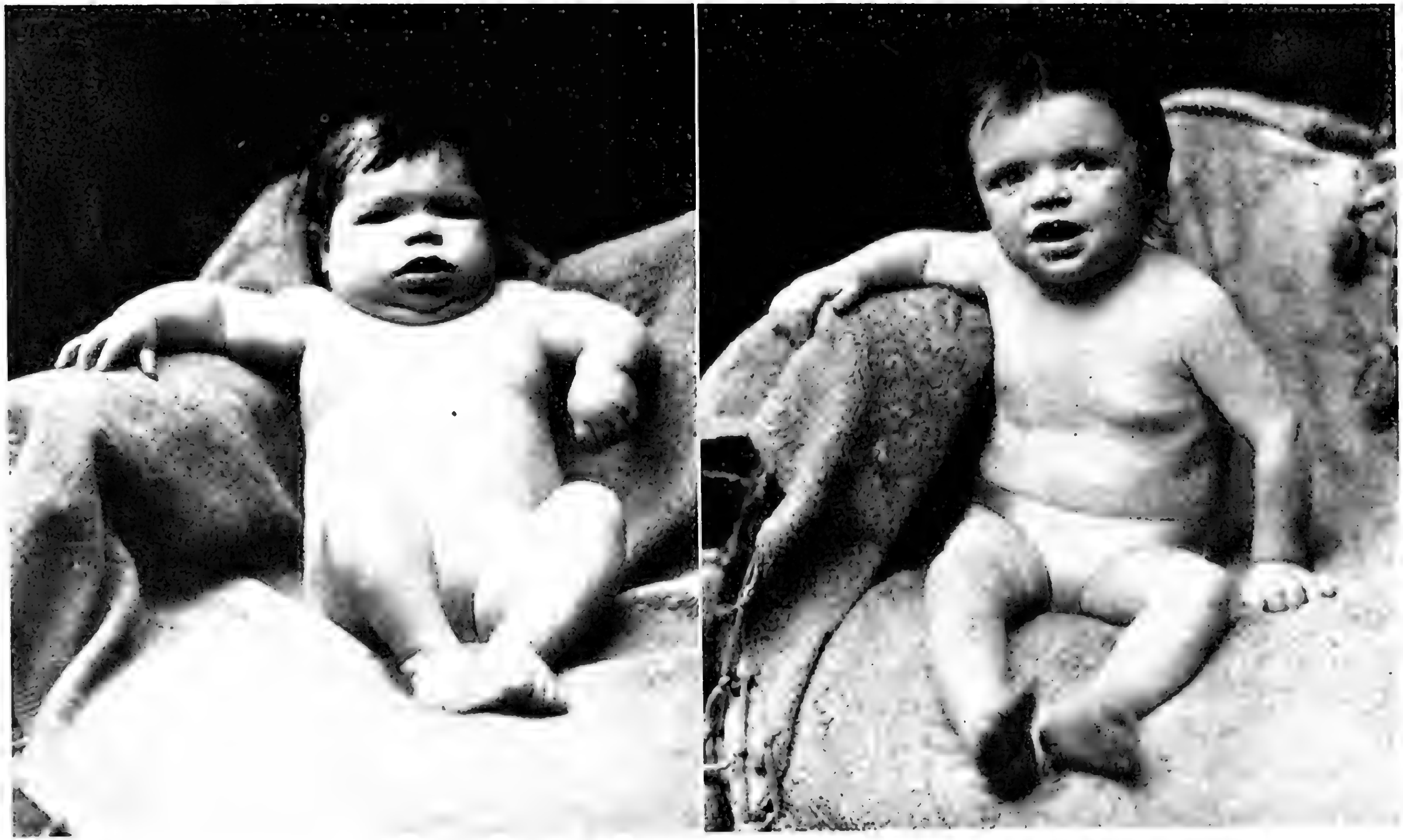
A B



THYROID TREATMENT BEGUN IN TIME

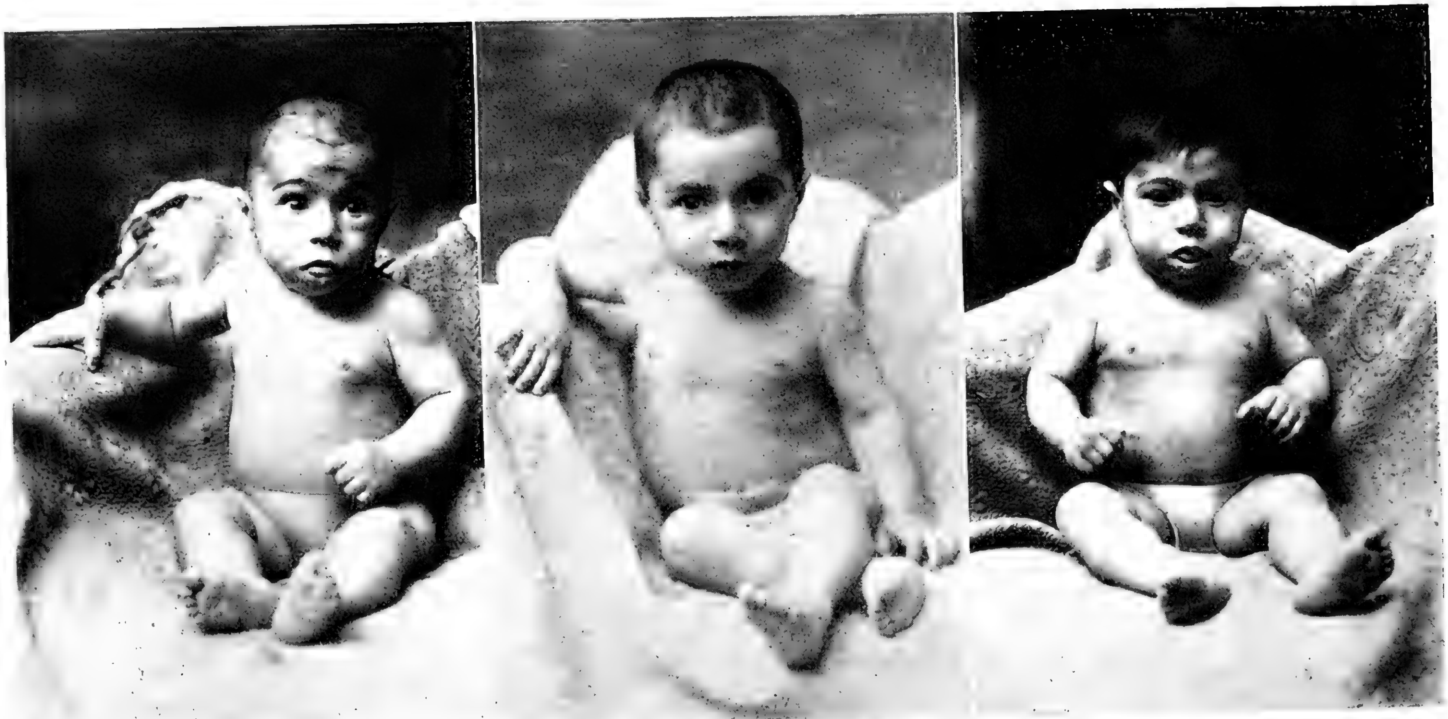
FIGURE 3. This child began treatment at the age of six months (A), and at two years its development is progressing normally (B). Compare with the untreated four-year-old child in the next picture.

A B



THE RESULT OF WAITING TOO LONG

FIGURE 4. During the first years of its life this child was treated for obesity, but thyroid substance was not administered until it was four years old (A). Two months later (B) great improvement is evident, but the child can never be normalized. The first four years, during which brain, bones, and hair failed to form properly, can never be recaptured from the past.



Before Treatment — Three Weeks of Thyroid Treatment — Treatment Discontinued Six Months

FAILURE TO CONTINUE TREATMENT SHOWS QUICKLY

FIGURE 5. As a result of thyroid treatment this child was well on its way toward normal development when the parents felt that a cure had been affected, and withdrew it from medical care. Six months later the child had nearly returned to the condition from which proper treatment had saved it.

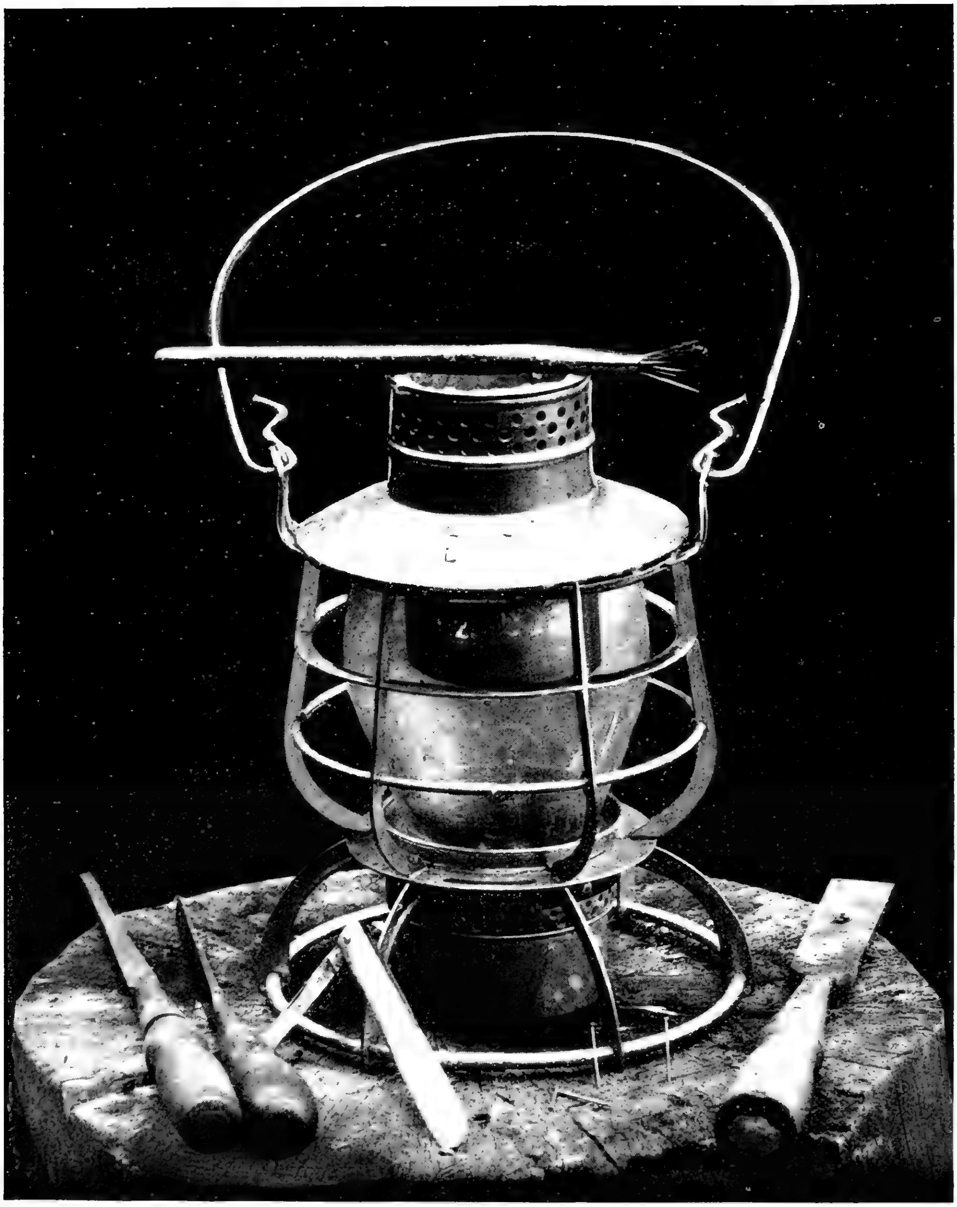
To illustrate this point, let us glance at Figure 4. Here is a child which was brought to me at the age of four years. It has been treated elsewhere for obesity, with the result of harm, instead of help. The thyroid gland is most seriously involved in this unfortunate. Photograph A shows the child as it appeared when brought to my clinic. Photograph B shows the same child after six weeks of treatment This child will be considerably helped, but there is no hope of normalizing it. The four first years, during which its brain, bones, and hair failed to form properly, cannot be recaptured from the past.

My intention, in this article, has been to contrast such feats of treatment as are now within our power, with the infinite mysteries still to be explored. It is clear beyond peradventure—or so it seems to me—that to disturbances of the chemical balance in the blood of mothers we will be able to trace far the greatest number of all cases of physical and mental malformation in children. It is even possible that more extensive investigations will widen the horizons in this field, and that we shall find this disturbance in the body of the mother directly responsible for faults and weaknesses in the child, whose connection with such disturbance has as yet been unsuspected.

The problem which stands immediately before us, however, is to gain such understanding of other gland involvements in children as we now possess in the matter of thyroid cases. We know full well that the pituitary gland is involved in certain of these pitiful malformations of human beings. We know, less certainly, that the suprarenals, the pineal, the interstitials and the thymus also play their parts. But to date we have not been able to determine the precise nature of their influence or of the disturbances to which they are liable. Still worse, in cases where we have been able to guess at the involvement of these other endocrines, we have been unable to treat the condition effectively. The task which confronts us, therefore, is to explore both the nature of the disorders due to the derangement of other glands, and the manner of administering the missing hormone substances. As yet we can do the latter with full success only in thyroid cases.

It seems to me that our total energies ought to be brought to this work of research, in the laboratory and in the clinic. We must lay less stress upon devising mentality tests and the like, which deal merely with the symptomatology of the subject; and we must devote ourselves whole-heartedly to the quest after the etiology of these terrible and grotesque afflictions. Such tests are of unquestioned value in the diagnosis and classification of mental abnormalities, but to look to them for light upon the prevention and treatment of these conditions would be to place ourselves in the position of general medicine in the middle of the last century when symptoms, instead of causes, were being treated—and with what lamentable results! It is obvious that no amount of education of function can remedy ills dependent upon malformation of the essential machinery of the human mind; neither can it supply any of the missing chemicals which furnish the necessary food for this machinery.

The way lies straight, it seems to me. We know the general causes of most defectiveness and malformity. Our duty is to search out the specific causes for each form known to medicine. Once this etiology is in hand it will be but a step to devise practical methods of operation.



SOME OF THE TOOLS USED IN "SLOT GRAFTING"

FIGURE 6. The most important is the "Merrybook Melter," an ordinary railroad lantern with a deep cup fitted into its top for holding melted parafine, and an alcohol lamp in place of the kerosene burner of the lantern. Chisels, brads, and stout knife are the other requisites. (Photographs for Figures 6-11 by Robert Cook and the author).

A NEW METHOD OF GRAFTING

Modification of the Morris Proximal Slot-Graft Successful With Plants Not Heretofore Grafted—Method of Value To Plant Breeders

T. Ralph Robinson

Bureau of Plant Industry, Washington, D. C.

THE experimenter with woody plants is confronted with the problem of propagating the superior varieties that he produces. Any improvements of existing methods of budding or grafting should therefore be of direct interest and importance to plant geneticists, as well as to plant lovers and horiculturists, both amateur and professional.

A method that has a number of advantages over those generally used has been developed recently. It would appear to have a wide application, and it is hoped that the brief description which follows may lead to further experimentation and improvements.

Dr. Robert T. Morris, in his book on "Nut Growing," describes a method he has used with considerable success in grafting nut-bearing trees. He calls it the "proximal slot-graft." Besides the technique involved in the method of inserting the graft, a vital part of the process is the use of melted paraffin as a covering instead of the usual grafting wax. Dr. Morris also lays considerable emphasis on some ingenious methods of wrapping, when working with nut trees.

The Morris method in its main features has been tried out during the past year in Florida on subtrophical fruit trees, chiefly citrus, avocados, and mangos. Mr. James W. Barney, of Palma Sola, Florida, was the first to demonstrate the success of grafting with the aid of paraffin, using the slot-graft method. He modified Dr. Morris' procedure, however, and simplified the technique very materially by doing away with all wrappings, substituting for them a fine brad driven through the graft into the wood of the tree. Besides insuring a close contact not easily disturbed, it permits the paraffin covering to be applied in the most thorough and effective manner—a somewhat more difficult operation when a complicated wrapping is used.

At the April (1923) meeting of the Florida State Horticultural Society, at Orlando, Mr. Barney gave an account of his preliminary experiments. Since then others have been using this method with similar results. The writer has been in touch with Mr. Barney's work and has had sufficient experience in the use of the method to feel sure it can be used to advantage in working over many kinds of fruit trees. Mr. Barney has even succeded in grafting guavas, which is usually regarded as impossible.

The accompanying photographs are designed to show only the main steps in the process of inserting the "proximal slot-graft," some of the more obvious operations not being shown.

First, a cut is made with a chisel or gouge downward and penetrating slightly through the bark into the wood of the stock. A transverse cut is then made at the base of the first cut, providing a shallow niche, with a slight shelf at the bottom (Figure 7). The exposed surface is immediately painted over with melted paraffin, just warm enough to stay in a liquid condition. The paraffin brush should first be tried on the hand; if it proves hot enough to burn, it should be cooled off before using. The graft should then be prepared by tapering to a wedge shape, one side of the wedge longer than the

MARKING AND CUTTING THE "SLOT"

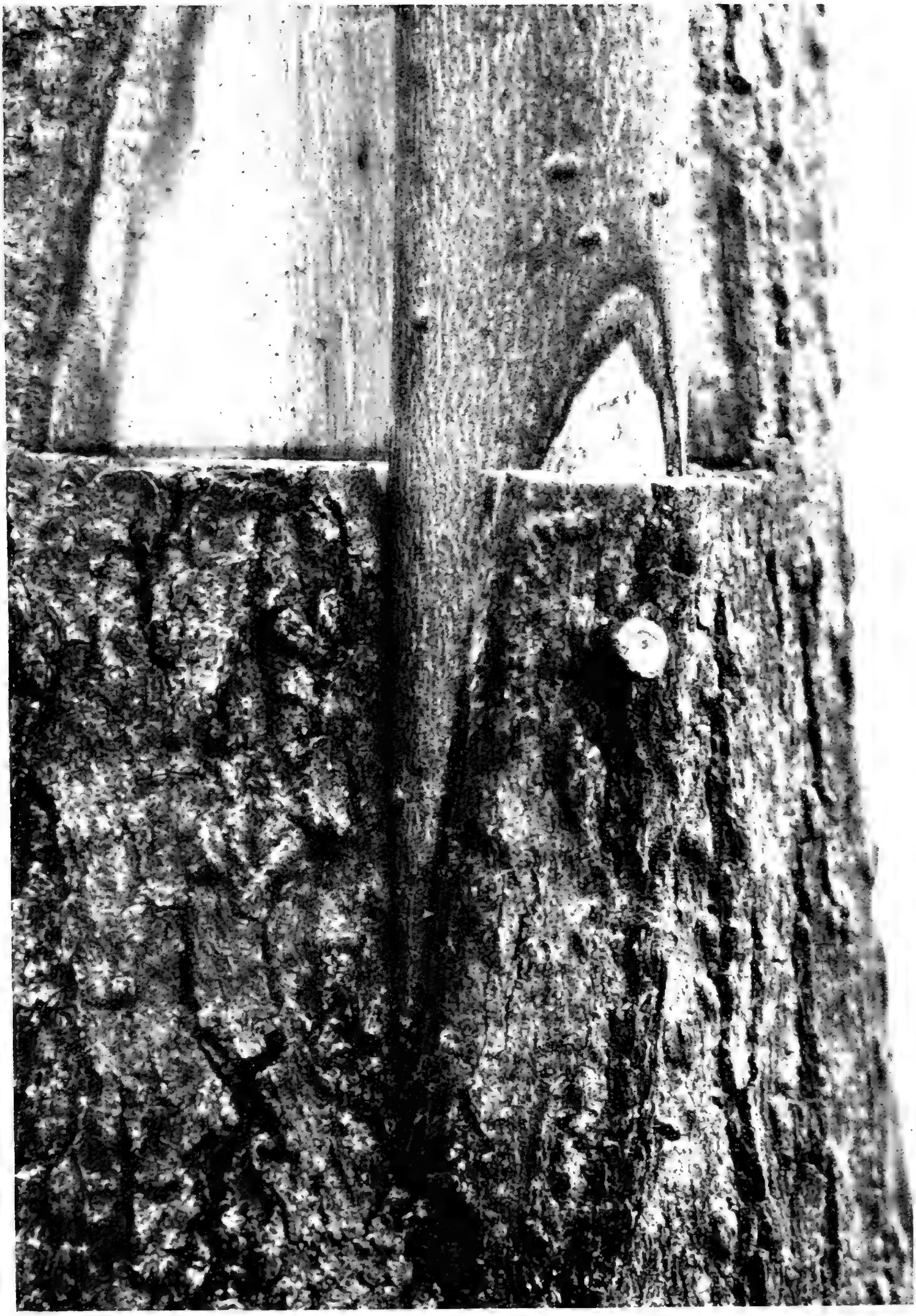
FIGURES 7 AND 8. A notch is cut in the stock so that the shelf at its base is at the point selected to insert the graft. The exposed surface is immediately coated with melted paraffin. Next, the chosen piece of grafting wood is prepared by cutting its base to a wedge-shape. The graft is then used as a guide in making two parallel cuts in the bark of the stock, downward from the base of the notch (Figure 7). The tongue of bark between the two cuts is then lifted carefully with a narrow chisel, but not removed (Figure 8).

INSERTING THE GRAFT

FIGURE 9. The prepared graft is then inserted in the "slot"—with the longer edge of the wedge next to the wood. When the graft has been forced gently but firmly into place a fine brad is driven through both bark and graft into the solid wood.

THE FINISHED GRAFT

FIGURE 10. After the brad is in place all exposed surfaces, and the entire graft as well, are carefully covered over with melted paraffin, which must be fluid, but not hot enough to injure the delicate cut surfaces.



ENLARGED VIEW OF GRAFT

FIGURE 11. This shows the completed graft before it has received its coating of paraffin. If stock and scion have been well chosen, and a good contact secured between them, the only other attention necessary is to cut back the stock and force the graft into growth after a good union is apparent.


TWO EXAMPLES OF SUCCESSFUL SLOT-GRAFTING

FIGURE 12. On the left is shown a Chinese walnut grafted on a butternut on June 20th, 1923, the healthy shoot represents the growth made during the remainder of the season. In some climates the use of a brad to fasten the graft in place has been reported to be unsatisfactory as the iron rusts and becomes a center of infection. The use of a small copper or brass nail has been suggested as a remedy for this. Photograph by Dr. G. A. Zimmerman.

(*Right*)—Mango grafts making rapid growth two months after inserting into the main branches of an old mango tree: an example of the successful application of the slot-graft method by James W. Barney of Palma Sola, Florida. The mass of leaves showing at the top of the picture has all been produced by the two-months-old grafts.

other, but with the sharp end of the wedge about the middle of the diameter of the stick. The graft selected should have two or more good buds above the tapered portion. The cuts made should be smooth and continuous, which requires a strong sharp knife and a steady hand.

The next step is to measure off and mark the width of the graft on the cross cut on the small shelf just described. With a knife or chisel, two vertical parallel cuts are then made downward from the cross cut just deep enough to go through the bark, the cuts being made about as long as the tapered end of the graft. Care should be taken that these cuts are only just wide enough apart to allow the graft to slip into place (Figure 7).

The tongue of bark lying between these cuts is then gently lifted (Figure 8), using a bone or chisel of appropriate width.

The prepared graft is then gently but firmly inserted in the "slot" thus prepared—placing the long cut of the tapered end next to the wood of the branch or trunk of the tree. When pushed down to a good fit, the raised tongue of bark is held firmly against the inserted graft and a fine brad (No. 18 gauge) is driven through the bark and graft into the solid wood. This brad is placed near the upper end of the tongue of bark (Figure 11). Melted paraffin is then applied with a fine brush so as to cover all exposed surfaces and fill every crevice, at the same time applying a light coating over the entire surface of the graft itself. The job is done. If a good contact is secured and stock and scion are reasonably well chosen, the only further attention needed is the cutting back or girdling of the top to force the scion into growth after a good union is apparent.

When ants or bees are active the paraffin covering may need renewing before the union is entirely safe. If exposed to hot sunlight, shading may be necessary. Brads of three-quarter inch length are usually about right, although several sizes may be carried along for different sized grafts. The new growth starting from the graft should be tied up securely to appropriately placed supports.

One accessory invented by Dr. Morris has made this method really practical for the orchardist, namely, the "Merribook Melter." As shown in the photograph (Figure 6), this paraffin melter simply is a lantern with a cup set in the top to hold the paraffin. An alcohol burner is used in the base, having a small wick that can be turned down to mere point of flame, thus rendering it easy to keep the paraffin in a melted condition, but not too hot. The lantern can be hung in the branches of a tree or set on the ground without danger of upsetting. Any of the common paraffins used in preserving, as "Para wax," "Gulf wax," have a sufficiently low melting point to be suitable for covering grafts. Paraffin being translucent, allows the chlorophyll in the bark of the graft to continue functioning and may assist in bringing about a prompt union between stock and scion. Adding three to five per cent of Carnuba wax to the paraffin causes it to flake off when growth starts, and prevents sun scalding.

As in all successful grafting operations, good workmanship is essential, but with average care the paraffin method will give results considerably in advance of the older methods and can be learned by novices with little difficulty.

The topworking of old fruit trees has always offered somewhat of a problem, particularly as to choice of method. Practically all methods, however, involve severe cutting back as a preliminary step, with resulting shock and loss of crop and possible failure of buds or grafts even after such heroic treatment. Some method that permits the retention of the top until after the new graft has taken and started growth has obvious advantages. The wider use of the method should facilitate the reworking of inferior fruit trees to better sorts.

MENDELIAN ANALYSIS OF THE PURE BREEDS OF LIVESTOCK

II. The Duchess Family of Shorthorns As Bred By Thomas Bates

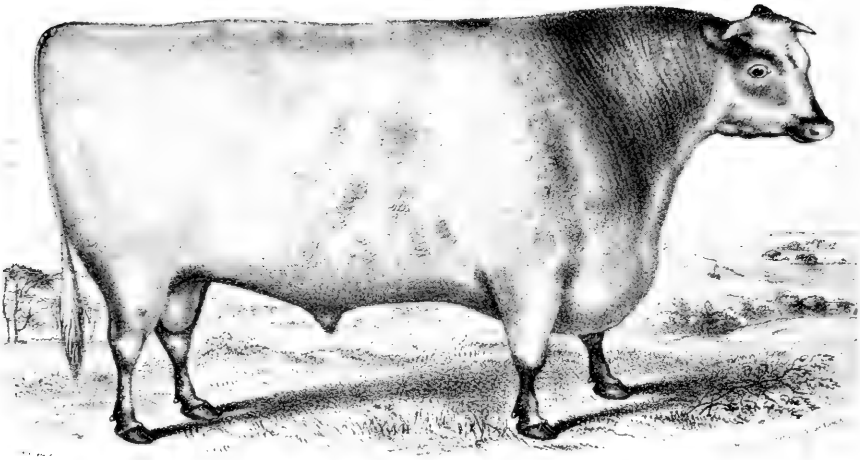
Sewall Wright

Bureau of Animal Industry, United States Department of Agriculture, Washington, D. C.

A VARIETY of cattle with short horns and red, roan, and white as the prevalent colors had long been established in parts of Durham, Yorkshire and surrounding counties in England and had been bred to a fair degree of excellence by the middle of the eighteenth century. They have been described from contemporary accounts as "generally wide-backed, well-framed cows, deep in their fore-quarters, soft and mellow in their hair and handling and possessing, with average milking qualities, a remarkable disposition to fatten. Their horns were rather longer than those of their descendants of the present day and inclining upward. The defects were those of an undue prominence of the hip and shoulder point, a want of length in the hind quarters, of width in the floor of the chest, of fullness generally before and behind the shoulders, as well as of flesh upon the shoulder itself. They had a somewhat disproportionate abdomen, were too long in the legs and showed a want of substance, indicative of delicacy, in the hide. They failed also in the essential requisite of taking on their flesh evenly and firmly over the whole frame, which frequently gave them an unlevel appearance. There was, moreover, a general want of compactness in their conformation." This foundation stock was thus decidedly open to improvement. In fact, Robert Bakewell of Dishley, whose leadership in the improvement of cattle and sheep we have already mentioned[2]* is said to have kept a few of the old sort merely to set off his improved Longhorns.

The foundations for the improvement of the Shorthorns were laid by Charles Colling of Ketton farm, who made a prolonged study of Bakewell's methods at Dishley in 1783. In the following year he bought, among other cattle, a massive, short-legged, wide-backed cow named Duchess, who became the progenitress of the family which we are to study. Meanwhile Robert Colling, a brother of Charles, purchased the bull Hubback, who came to be considered the best Shorthorn bull of the time. One of his grandsons was the noted bull Foljambe. Charles Colling seems to have been sufficiently impressed with the merit of the produce of Foljambe to begin efforts at fixing their qualities by inbreeding. A daughter, Phoenix, was bred to a son, Bolingbroke, and produced (in 1793) the bull Favourite, whose pedigree we have already considered. Favourite was inbred to a very appreciable extent (F = 19.2 per cent), not only through Foljambe but through his granddams, one of which was the dam of the other. He is described as "a large massive bull of good constitution with a fine bold eye, remarkably good loins and long level hind quarters." Mr. Colling was so satisfied with Favourite that he began breeding him to his daughters and granddaughters, in some cases even for five or six generations. Through the demand for

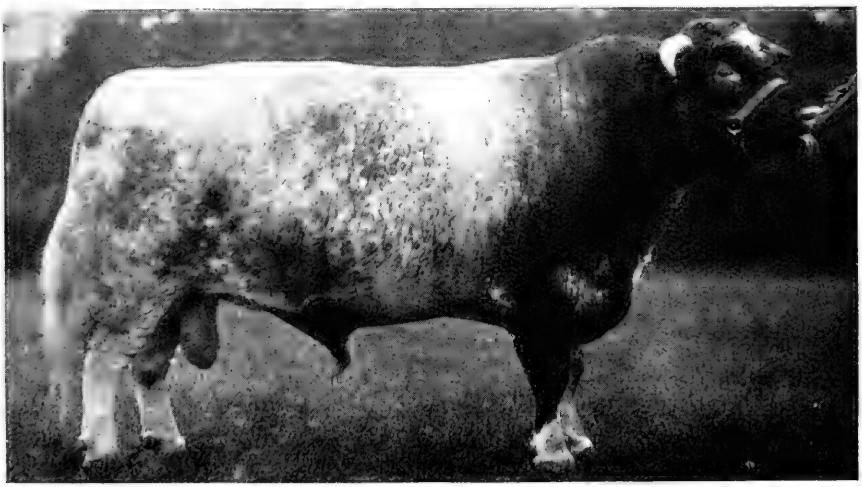
*For numbered references see "Literature Cited" at end of article.



DUKE OF NORTHUMBERLAND

FIGURE 13. Bates is considered to have won his greatest triumph as a breeder in producing the Duke of Northumberland (1940) from a mating of Duchess 34th with her own sire, Belvidere.* Duke of Northumberland won first prize at the Oxford Royal Show of 1839 and was generally conceded to be the best bull in England in his time. Without taking the old lithographs too seriously, we may infer from them that Bates was aiming at a compact build, smoothness, and great fineness of bone, and that he came near achieving his ideal in Duke of Northumberland.

*Correct spelling **Belvedere.** Error in spelling this name noted just before going to press, and too late to change.



A PRESENT DAY SHORTHORN CHAMPION

FIGURE 14. A comparison between the photograph of this bull and the lithographs of the Bates' cattle brings out the greater ruggedness of type that has come into favor, even after due allowance is made for the obvious exaggeration of the old illustrations.

bulls of Colling's improved stock, his blood undoubtedly became more widely distributed in the developing breed than that of any other one animal. Darwin[1] cites his case as an illustration of prepotency. As we shall see, Bates maintained a coefficient of relationship to Favourite of about 60 per cent in his Duchess family for forty years after Favourite's death (in 1809).

At the dispersion sale of Charles Colling's herd, in 1810, forty-seven head, all by Favourite or his son Comet or their get, sold for £7,115, an unprecedented amount. The record price, 1,000 guineas, was paid for Comet, a son of Favourite, dam by Favourite and out of Favourite's dam. This remarkably inbred animal (F = 47.1 per cent) was declared by Mr. Colling to be the best bull he ever bred or saw. For years after, it seems to have been the general opinion that no Shorthorn bull had ever been quite the equal of Comet. Mr. Colling's stock are described by a contemporary, as of great size and substance, fine long hind quarters, space from hip to rib long and counteracted by a broad back and high round ribs.

The Duchesses

One of the bidders at this dispersion sale was a young breeder, Thomas Bates, who had made a careful study of cattle pedigrees. He purchased a rather "shabby" cow called Young Duchess, largely, it appears, on the strength of her pedigree, her top sires being Comet, Favourite, Daisy Bull (a son of Favourite), Favourite again, and Hubback. She was a descendent in the straight female line of the cow Duchess purchased by Charles Colling in 1784. Following the custom of naming families by the female line, Bates developed a Duchess family from this cow, which he renamed Duchess I. Up to the time of his death in 1849 he had bred sixty-three cows in the family which he named Duchess 2 to Duchess 64. Two other females are recorded as having died. Forty-five males are recorded as dropped by Duchess cows, twenty-nine of which were named. The family was not a prolific one. They won, however, an extraordinary reputation. The Duchess bull, Duke of Northumberland, which won first at the Oxford Royal Show of 1839, was conceded to be the best bull in England in his time. Bates had other notable successes in the show yard although an opponent of the system of specially fitting for the shows.

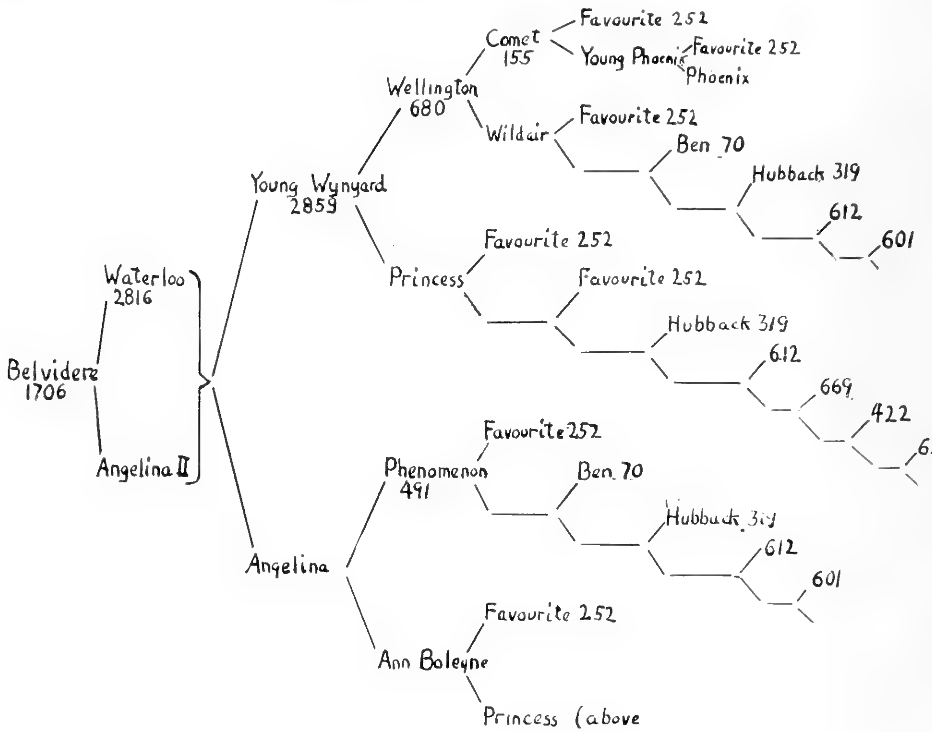
This reputation extended to America and Bates-bred cattle, especially bulls of the Duchess family, played a notable part in the improvement of American Shorthorns.

After Bates' death, a line of Duchesses was maintained without outcrossing. These became the aristocrats of the cattle world. The family had never been a prolific one and became increasingly difficult to maintain as a pure strain. This, however, does not seem to have been held as a detriment but rather the reverse, since it resulted in enhanced values due to scarcity. The climax came in a sale at New York Mills, near Utica, N. Y., in 1873. The "pure" line of Duchesses had become extinct in England and all in America had come into the hands of one man. The sale at New York Mills developed into an international competition for the "pure" Duchesses. One cow sold for $40,600. The average of the eleven Duchess cows was $21,705, that for three bulls was $7,866.

While these prices were largely speculative and the real merit of the family was falling off, in the hands of the speculators as the prices mounted higher, the fact remains that as bred by Bates, the Duchess cattle were a most notable achievement of breeding skill. Through crosses with other lines they have had a conspicuous part in the improvement of the Shorthorn breed.

Description of Tables

The sixty-three Duchesses bred by Bates, and their ancestors in the straight female line are listed in Table II with



THE PEDIGREE OF BELVIDERE

FIGURE 15. The purchase of Belvidere (1706) from Mr. Stevenson is considered to mark the turning point in Bates' career. Note that Belvidere's sire and dam were full brother and sister, making possible condensation of the pedigree as indicated.

their date of birth and the dam and sire of each. The coefficient of inbreeding has been calculated as described[2], for all of these animals and is given in the next three columns. The relationship of the sires and dams of the Duchesses is given in the next column. Finally it is of interest to find how far there was relationship to Favourite, the bull to which the greater part of the inbreeding is due. The last three columns are devoted to this purpose, dealing with the individual and her sire and dam respectively.

All pedigrees have been traced to the beginning of the Coates' herd books in making these calculations. They naturally become very complex after a few generations. The labor in calculating the coefficients is not so great as might be imagined, however, since the calculation of the contribution to inbreeding or relationship made by two animals on opposite sides of a pedigree can be used in all other pedigrees in which these same animals appear on opposite sides. In the course of the work a list was made of the contributions due to the various important sires with each other and with the more important cows. The parentage of the sires is given in Table I. It will be noticed that all but four of the twenty-five of them were from sires that appear earlier in the list and that eleven of them were from Duchess cows. The pedigrees can be practically completed by reference to the notes and to the pedigrees of Favourite[2], 2nd Hubback, Belvidere, Gambier and Norfolk (Figures 15-18).

Relationship of Sires and Dams

The results are summed up in Table III by generations and are presented graphically in Figures 21, 24 and 25. Duchess 59 and 62 were eight generations from Duchess I, and thirteen generations from the original Duchess purchased by Charles Colling in 1784.

The coefficients of relationship between sire and dam are given in Figure 21. For three generations there was little or no relationship. For Duchess by Daisy Bull in the next generation the coefficient rises to 39 per cent, both sire and dam having been progeny of Favourite. The parents of Duchess by Favourite and Duchess I (by Comet) in the next two generations show coefficients of 53 per cent and 59 per cent respectively. These figures are to be compared with coefficients of 50 per cent between ordinary brothers and sisters or between parent and offspring in a random-bred stock. They measure the actual correlation in appearance in characters which are wholly determined by nondominant genetic factors. They are doubtless about what the reader would expect from a cursory examination of the pedigrees.

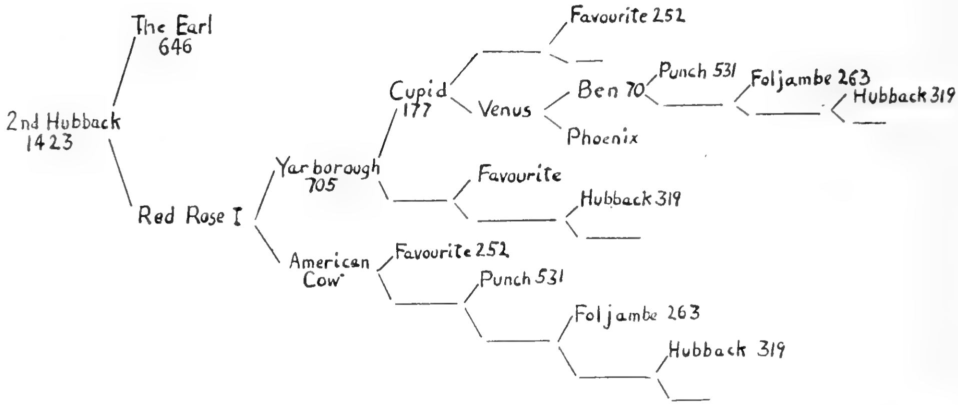
It is not so obvious, however, what the correlations in later generations should be. The general opinion has been that Bates began his career with very intensive inbreeding and on encountering deterioration was obliged to make outcrosses. Darwin[1] states, "For thirteen years he bred most closely in-and-in; but during the next seventeen years, although he had the most exalted notion of his own stock, he thrice infused fresh blood into his herd; it is said that he did this not to improve the form of the animals, but on account of their lessened fertility."

The calculation of the actual relationships of the sires and dams, however, shows no such history. The sire and dam of Bates' purchase, Duchess I, were correlated about 0.59 ($R = 59$ per cent) on account of relationship. During the eight generations bred by Bates, he practically maintained the same level of relationship, the coefficients fluctuating about 60 per cent. The parents of the ten cows of the second generation after Duchess I were correlated 0.67, the high point, while the parents of the nine cows of the fifth generation were correlated only 0.52 at the other extreme. The average for the next generation, however, was 0.64 and the eighth generation averaged 0.63. Turning to individuals, the high point was reached in the mating which produced Duchess 21, where the coefficient is 87 per cent. The low point was reached in Duchess 41, where it was 42 per cent.

The purchase of the "Princess" bull Belvidere is generally given as the turning point in Bates' career, the point at which he found it necessary to introduce fresh blood and the point with which his greatest success began. It is true that Belvidere had no Duchess blood. He was, however, rich in the blood of Favourite as may be seen from his pedigree (Figure 15). His relationship with Favourite was about 65 per cent. In fact his relationship with Duchess 19 and with Duchess 29, the cows of the Duchess family with which he was first mated, were as high as 45 per cent and 47 per cent respectively.

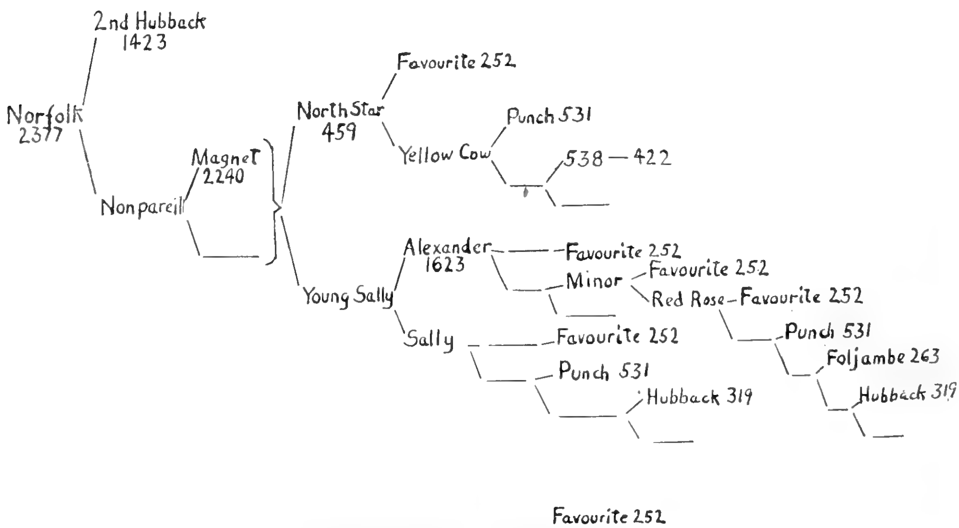
Previous to the use of Belvidere, outside blood was introduced through 2nd Hubback. However, while Red Rose I, his dam, had no Duchess blood, she was closely related genetically (see pedigree, Figure 16). Moreover the sire of 2nd Hubback was the Duchess bull, The Earl. Second Hubback should have shown a correlation of about .65 with Favourite as far as all purely hereditary characters were concerned and correlations .49 and .62 with the first Duchesses with which he was mated.

Fresh blood was introduced later through the bulls Gambier and Norfolk, bred by Jonas Whitaker, which were without Duchess blood on either side of their pedigrees (Figures 17 and 18). Nevertheless both of these bulls were closely related to Favourite (65 per



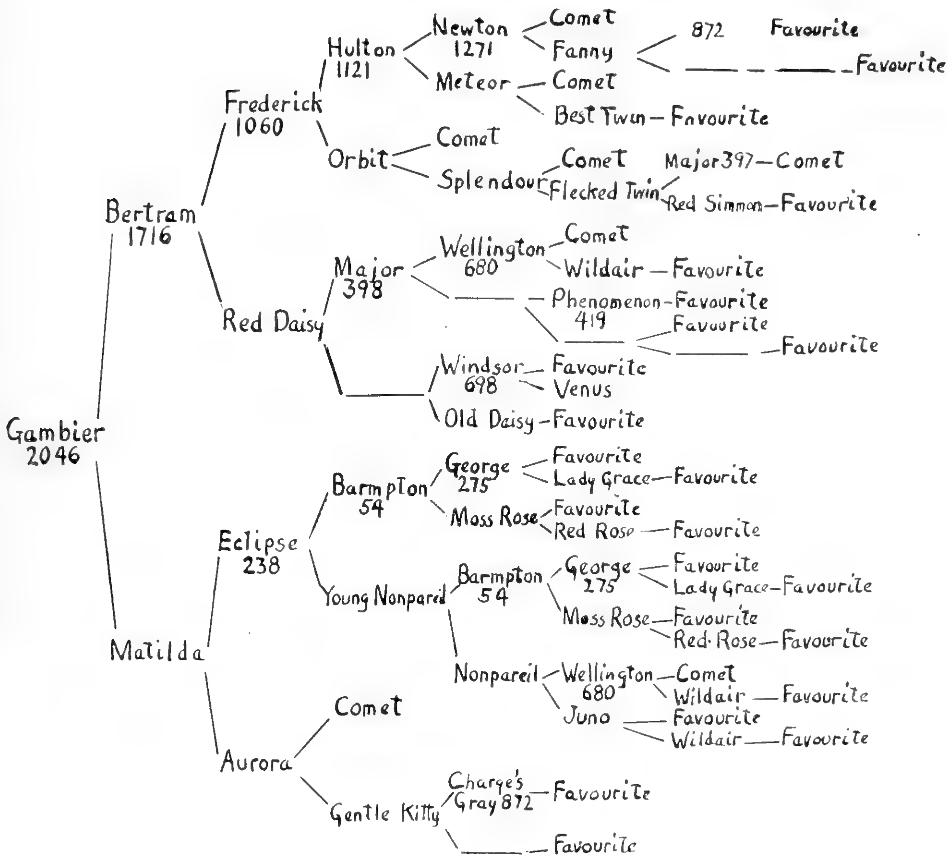
THE PEDIGREE OF 2ND HUBBACK

FIGURE 16. Second Hubback (1423) was one of the bulls used by Bates to keep the degree of inbreeding in his Duchess herd from rising too high. The pedigree of 2nd Hubback's sire is given in Table I and is not repeated here.



PEDIGREE OF NORFOLK

FIGURE 17. The bull Norfolk (2377), bred by Mr. Whitaker, had no Duchess blood, but was closely related to Favourite, as the pedigree shows. The pedigree of the sire, 2nd Hubback, is given above, and in Table I and hence is not repeated.



PEDIGREE OF GAMBIER

FIGURE 18. The bull Gambier (2046) was bred by Jonas Whitaker. The numerous lines tracing to Favourite (252) and Comet (155), the son of Favourite, are shown. There are, however, other lines early in the pedigree which trace to the bulls, Foljambe, Dalton Duke, Hubback, Ben, and Punch, and to the cow Phoenix (Dam of Favourite), which are not shown to avoid undue complexity, but are taken account of in calculating coefficients of inbreeding and relationship.

cent and 55 per cent respectively), and both were genetically almost as closely related to the Duchess with which they were mated as ordinary full brothers and sisters (47 per cent and 49 per cent).

The most important "outcrosses" in the later years were those with the descendants of the Matchem Cow. The latter was not closely related to the Duchesses or even to Favourite ($R = 22$ per cent), but as her blood was introduced into the Duchess line only through her sons, the Cleveland Lads, sired by the Duchess bull, Shorttail, and through her grandson, 2nd Duke of Oxford, with two Duchess top crosses, the result was merely that Bates kept the degree of inbreeding from rising above its previous level by introducing this dash of outside blood.

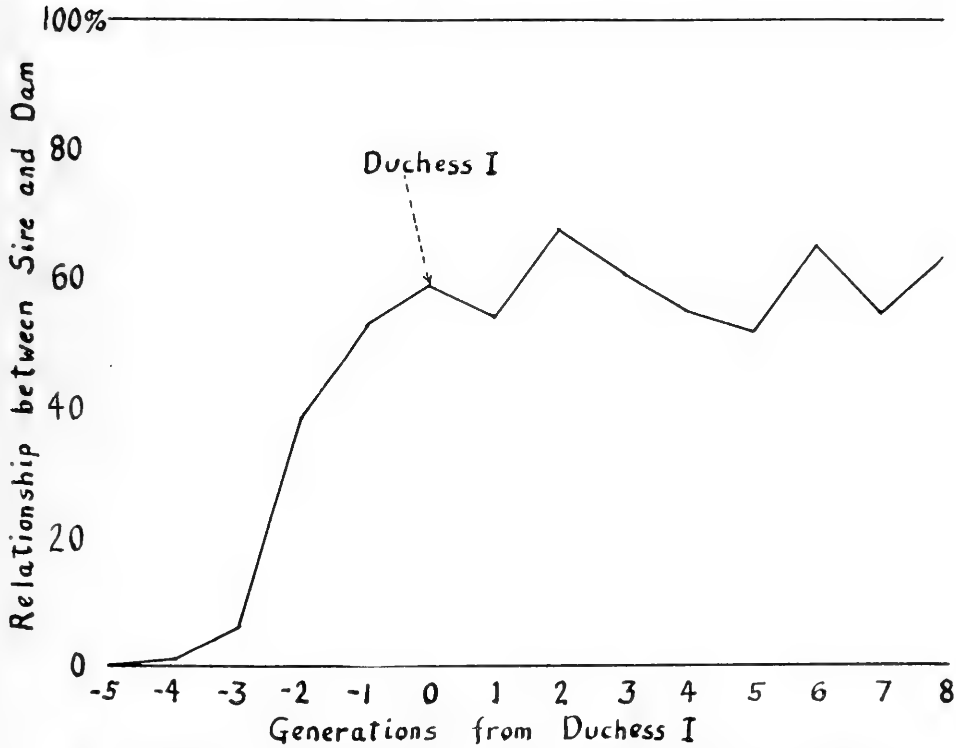
We must conclude that Bates simply maintained from the beginning to the end of his breeding career a certain average degree of relationship between the animals he mated (about 60 per cent), a degree distinctly higher than that between an ordinary brother and

BELVIDERE

FIGURE 19. Bates' greatest success began with the use of the "Princess" bull, Belvidere (1706), which, although lacking in Duchess blood, was closely inbred to the foundation sire, Favourite, and through the latter was as closely related to the Duchess cows as an ordinary full brother.

OLD BROKEN-LEG

FIGURE 20. Daughter of Belvidere and dam of Duke of Northumberland, Old Broken Leg (Duchess 34th) was one of Bates' most famous Duchesses. Her merits as an individual were established by her notable victory over John Booth's cow, Necklace, at the York show in 1842.



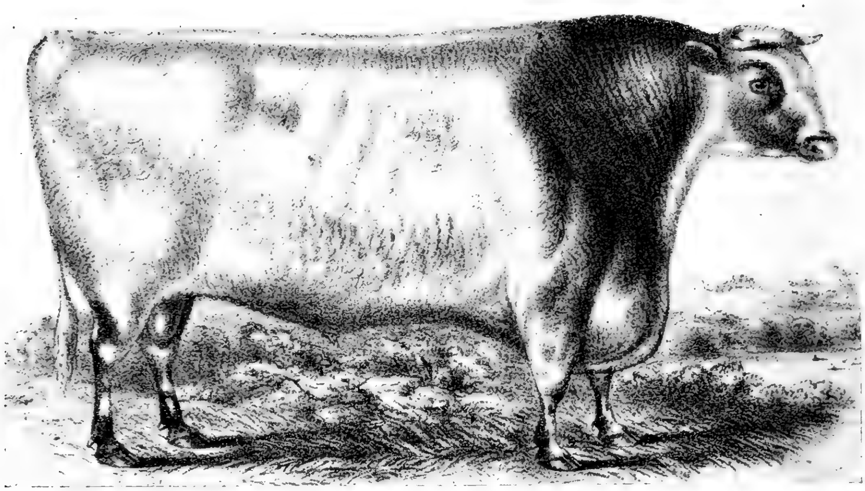
RELATIONSHIP BETWEEN SIRES AND DAMS OF THE DUCHESSES

FIGURE 21. The degrees of relationship between the sires and dams of the eight generations of Duchesses bred by Thomas Bates and six earlier generations in the straight female line. The coefficients of relationship are theoretically equal to the coefficients of correlation with respect to characters which are wholly hereditary and lacking in dominance.

sister. He constantly introduced fresh blood but only to such an extent as to prevent the relationship from rising above this level.

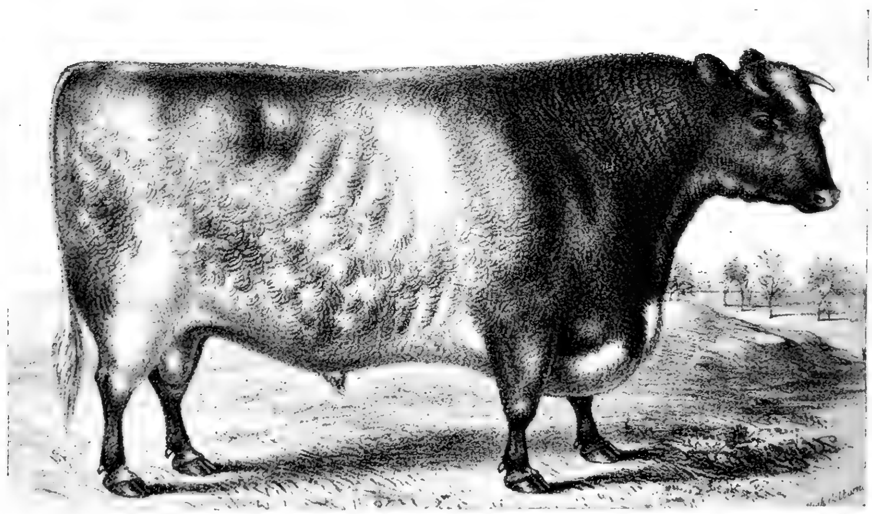
The Degree of Inbreeding Used by Bates

The coefficients of inbreeding of the thirteen generations of Duchesses are shown in the solid line in Figure 24. That of their dams (also, of course, Duchesses, but in a different order) and of their sires are given in dotted and broken lines respectively. The striking feature of this diagram is the similarity of the three lines at a constant level of about 40 per cent beginning with Duchess I. Duchess by Daisy Bull, two generations earlier, is the first Duchess which shows an appreciable amount of inbreeding (20 per cent). Duchess by Favourite in the next generation rises to 32 per cent. Duchess I, bred by Colling and purchased by Bates, rises to 41 per cent. From this point on no generation rises above 47 per cent or falls below 36 per cent. The coefficient for the last generation, 43 per cent, is practically the same as that for Duchess I and for the average of the first two generations which Bates himself bred. This level of inbreeding is approximately equivalent to two generations of straight brother-sister mating, something over four generations of pure breeding within a herd (half brother-sister mating) and six generations of double first-cousin mating. In maintaining it, Bates used bulls, wheth-



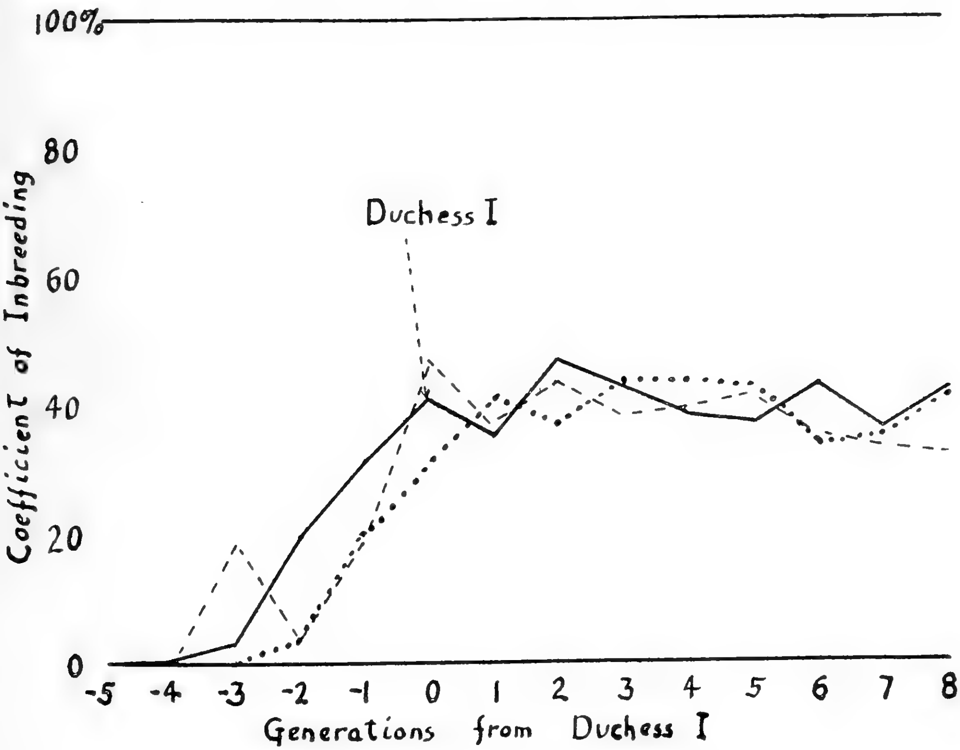
COMET

FIGURE 22. The bull Comet (155), bred by Charles Colling, was one of the most important foundation sires of the Shorthorn breed. He was the sire of Bates' Duchess I. In spite of his close inbreeding, 47.1 per cent, he was a remarkably vigorous animal and considered the best bull of his time. At Charles Colling's dispersion sale he sold for the record price of 1,000 guineas.



NORFOLK

FIGURE 23. Norfolk (2377), bred by James Whitaker, was one of the bulls used by Bates to introduce a dash of fresh blood into his herd. Many of the later day Duchesses descended from him. Like the other bulls used by Bates for this purpose, he was closely related to the Duchesses genetically through his descent in many lines from Favourite. Bates' so-called "outcrosses" merely kept the degree of inbreeding from rising above the level—about 40 per cent—with which he started.



DEGREE OF INBREEDING OF THE DUCHESSES

FIGURE 24. The degrees of inbreeding of the Duchesses (solid line), of their sires (broken line), and dams (dotted line). The original Duchess was purchased by Charles Colling in 1784. Duchess I, five generations later, was purchased from Colling by Bates, who bred eight generations, including sixty-three cows, before his death in 1849. The coefficient of inbreeding measures the approach toward complete homozygosis. The coefficient of 40 per cent maintained by Bates means 40 per cent less heterozygosis than was present in the foundation stock.

er of his own or other breeding, which were inbred to substantially the same extent, 40 per cent, as the cows and related to them as we have seen, about 60 per cent. With regard to factors in which the original Shorthorns were only 50 per cent homozygous, the sires used by Bates and his whole Duchess family were about 70 per cent homozygous from the automatic effect of inbreeding alone.

Relationship to Favourite

Finally it is interesting to see how far Bates maintained relationship to the bull, Favourite, about which as we have seen the Collings centered their efforts at the improvement of Shorthorns. Figure 25 shows the coefficients for the generations of Duchesses in the solid line and those for their dams and sires in dotted and broken lines respectively. Favourite himself appears as a sire of two of the early Duchesses bred by Colling. Bates' Duchess I shows a relationship of 76 per cent. During the following generations bred by Bates, the relationship slowly falls from 69 per cent to about 57 per cent. It is noteworthy that the sires, the majority of which were bred by others, show practically the same coefficients as the Bates-bred cows with which they were bred.

While these lines show a gradual decline, it is a surprising result to find that Bates maintained a strain for forty years after the death of Favourite in which there was a distinctly closer relationship to the latter and hence presumably a closer resemblance than between an ordinary parent and offspring.

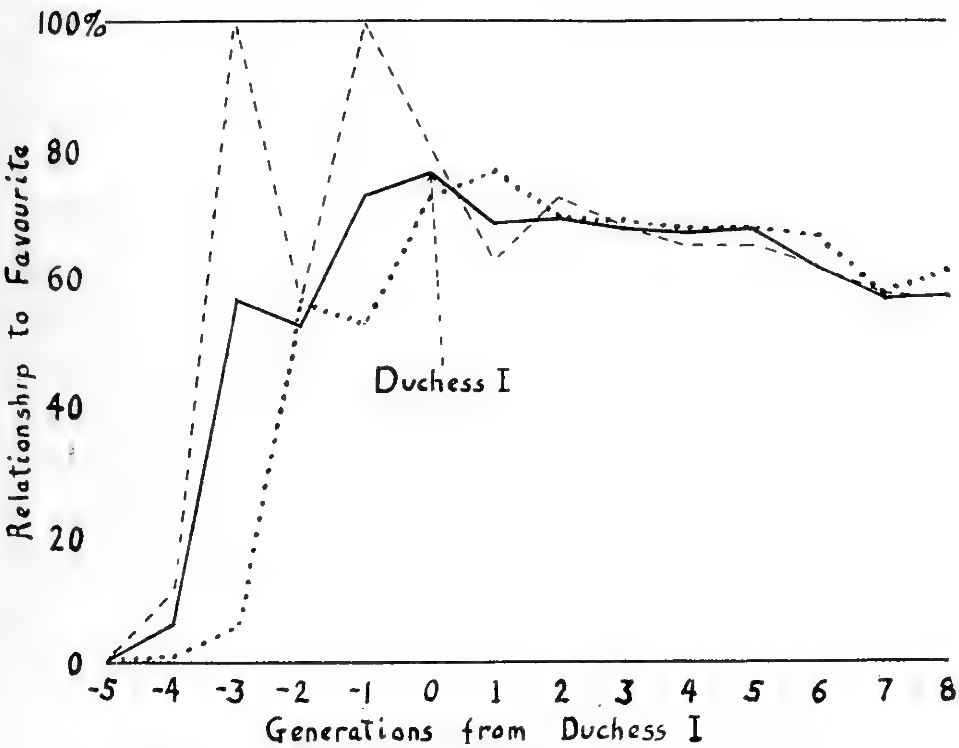
The Significance of Bates' Methods

Bates' own view of inbreeding is contained in a statement handed on by Darwin[1] "to breed in and in from a bad stock was ruin and devastation yet that the practice may be safely followed within certain limits when the parents so related are descended from first-rate animals."

The striking feature of his actual practices as brought out by the above diagrams is their uniformity throughout his whole career. He did not inbreed at the closest possible rate for a few generations and then make violent outcrosses. Neither did he concentrate the blood of one bull for a few generations and then turn to a wholly different line. Whatever the basis in his own mind, he actually pursued a steady policy—maintaining a relationship of nearly 60 per cent between the animals he mated, maintaining a coefficient of inbreeding of something over 40 per cent and maintaining a relationship to the foundation bull, Favourite, falling only slowly from 76 per cent to 57 per cent in eight generations. While our figures do not bring it out, it is well known that he also steadily selected for a certain type. The uniform degree of inbreeding was doubtless a somewhat unconscious result of a balancing between his desire to inbreed to maintain his type and his constant watchfulness over the characteristics of his animals, leading to prompt recognition of the need for a dash of fresh blood.

Through this system he must have been able to maintain without effort a close resemblance to Favourite in numerous features of quality and conformation. The fixation of characters (40 per cent), was not so great, however, but that there was variation and room for constant selection in which he could strengthen those features of the Ketton stock which he favored and get rid of those which he disliked. That he was able to mold the conformation into a distinctive type is the universal testimony of his contemporaries. One of these speaks of seeing his herd driven across country from Ridley Hall to Kirklevington in 1830, being "50 cows and heifers by 2nd Hubback, all as alike as beans and leaving a great impression wherever they passed." The Booths also founded their herds on Ketton stock and their animals would probably show relationship to Favourite of the order of those shown by the Duchesses. Indeed calculation would probably indicate a fairly close relationship between the Bates and Booth herds. Yet Bates and Booth types were recognized as distinctly different. This difference must have been due largely to selection.

Livestock breeders like to compare their work to that of one who molds figures in clay, as suggested above. The successful breeder is often spoken of as molding the conformation of his animals to the ideal type which he has in mind. If clay is to be worked into shape it must have just the right plasticity. Similarly with livestock. If Bates had not maintained close relationship between the animals which he mated, the relatively high degree of inbreeding, and close relationship to one animal (Favourite) his material would probably have been too plastic. The simultaneous variation in all characters would have been more than he could have contended with. If on the other hand he had bred wholly within his herd and between full brother and sister as far as possible, his material would soon not have been plastic enough to mold into shape. Undesirable characters, moreover, would almost certainly have become ineradicably fixed. As it was, a low level of fertility seems to have become fixed and to have doomed the efforts to maintain



RELATIONSHIP OF THE DUCHESS COWS TO FAVORITE

FIGURE 25. The degrees of relationship to the bull Favourite of the Duchesses (solid line), of their sires (broken line), and of their dams (dotted line). For eight generations Bates maintained a closer resemblance to Favourite than between parent and offspring (50 per cent) in a stock not inbred.

a "pure" Duchess strain after Bates' death. On the whole it must be conceded that Bates managed to maintain a happy medium with respect to the plasticity of his stock.

Let us compare a little more closely the methods followed by Bates and those suggested by Mendelian theory. In combining inbreeding and selection there are several methods which may logically be followed depending on the genetic complexity of the characters, the importance of environmental variation and such factors as the extent of the operations and the amount of risk to be undertaken.

The first step in any case should be selection of a vigorous foundation, approaching as closely as possible to the desired type. This was the step taken by the Collings in purchasing the original Duchess, Favourite Cow, the bull Hubback, and so forth.

With such a foundation stock, one might practice the most intensive inbreeding in a large number of distinct lines, knowing that most lines would inevitably deteriorate greatly, but trusting that a few would be found in which desirable qualities would become fixed, and in which the deterioration in any vital respect would be so slight that they could be maintained successfully. By crossing such lines which have withstood this acid test of inbreeding, one might reasonably hope to recover more than the original vigor and retain those characters which had

been fixed. Such a method is especially indicated where the characters are of a kind determined so slightly by heredity that genetic differences can be recognized only on comparing lines which have been kept distinct and free from outside blood. This method, an alternation of intensive inbreeding with selection and crossbreeding of the few successful lines must naturally be done on a large scale and with the undertaking of considerable risk. It is a method adapted rather to experiment stations than to private individuals. It is, however, an important method and has some parallel in the general history of the breeds. Many of the early breeders practiced close inbreeding. Only a few like the Collings were notably successful. The strains developed by these successful breeders were intercrossed to found the present pure breeds.

For the individual breeder, however, theory as well as practice indicate that the most reliable method is the maintenance of a steady level in closeness of breeding coupled with persistent selection toward the desired type, the requisite closeness of breeding depending, naturally, on the heterogeneity of the foundation animals and the breeder's skill as a judge of livestock.

Our analysis indicates that this was the method pursued by Bates. In view of Bates' success we may infer that the degree of inbreeding practiced by him, 40 per cent, represents about the right amount in the hands of an exceptionally able judge of cattle, working with a material as heterogeneous as the original Shorthorns.

Summary

It is shown that in establishing the famous Duchess family of Shorthorns, Thomas Bates started with Colling-bred stock already about 40 per cent inbred (i. e., which was 40 per cent less heterozygous than the original Shorthorns). During the eight generations which he bred himself, through a period of about forty years, he maintained substantially the same level of inbreeding by constantly introducing just the right amount of fresh blood to keep the percentage from rising above 40 per cent. He used bulls, whether of his own or other breeding, which averaged about 40 per cent inbred. The relationship between the Duchess cows and the bulls with which they were mated, whether bred by himself or others, was kept at such point that a correlation of about + .60 would be present in purely hereditary nondominant characters, throughout the eight generations. Finally during these eight generations a high correlation, falling gradually from .76 to .57 was maintained with Colling's bull, Favourite.

It is suggested that these levels of inbreeding and relationship yielded the proper balance between the extreme plasticity of the original heterogeneous Shorthorn stock and the more complete fixation of characters which would have resulted from closer inbreeding, to enable Bates, with his great skill as a judge of cattle to maintain a high degree of vigor and to mold a new type according to his ideals on the basis of the type represented by Charles Colling's bull, Favourite.

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[1] DARWIN, CHARLES. Animals and Plants Under Domestication, 1868.

[2] WRIGHT, S. Mendelian Analysis of the Pure Breeds of Livestock. I. The Measurement of Inbreeding and Relationship. *Journal of Heredity* 14:339-348. 1923.

Table I—*The parentage of the bulls used by Bates in developing his Duchess family.*

Bull	Sire	Dam
Favourite (252)	Bolingbroke (86)	Phoenix
Daisy Bull (186)	Favourite (252)	By Punch[1] (531) out of daughter of Hubback (319)
Comet (156)	Favourite (252)	Young Phoenix by Favourite out of Phoenix (his dam)
Ketton (709)	Favourite (252)	Duchess by Daisy Bull
Ketton II (710)	Ketton (709)	By son of Favourite out of daughter of J. Brown's bull[2] (97)
Ketton III (349)	Ketton II (710)	Duchess 3
Marske (418)	Favourite (252)	By Favourite out of daughter of Favourite[3]
Cleveland (146)	Ketton III (349)	Duchess 1
Young Marske (419)	Marske (418)	Duchess 4
The Earl (646)	Duke[4] (226)	Duchess 3
2nd Earl (1511)	The Earl (646)	Duchess 3
3rd Earl (1514)	The Earl (646)	Duchess 8
2nd Hubback (1423)	The Earl (646)	Red Rose I (see Figure 16) Angelina (see Figure 15)
Belvidere (1706)	Waterloo (2816)	Matilda (see Figure 18)
Gambier (2046)	Bertram (1716)	Nonpareil (see Figure 17)
Norfolk (2377)	2nd Hubback (1423)	Duchess 32
Shorttail (2621)	Belvidere (1706)	By 2nd Hubback out of daughter of 2nd Hubback[5]
Holkar (4041)	Belvidere (1706)	
Duke of Northumberland (1940)	Belvidere (1706)	Duchess 34
2nd Duke of Northumberland (3646)	Belvidere (1706)	Duchess 34
4th Duke of Northumberland (3649)	Shorttail (2621)	Duchess 34
Cleveland Lad (3407)	Shorttail (2621)	Matchem Cow[6]
2nd Cleveland Lad (3408)	Shorttail (2621)	Matchem Cow[6]
Lord Barrington (9308)	2nd Duke of Northumberland (3646)	By Cleveland Lad out of daughter of Belvidere[7]
2nd Duke of Oxford (9046)	Duke of Northumberland (1940)	Oxford 2nd (full sister of the Cleveland Lads)

[1] Punch was by Broken Horn (95) out of his own daughter. Broken Horn in turn was both son and grandson of Hubback (319), who thus appears four times in the ancestry of Punch within four generations.

[2] J. Brown's Bull (97) was a great grandson of the Studley Bull (626).

[3] The more remote top sires of Marske were Punch, Hubback, Snowden's Bull (612) and Masterman's Bull (422). The last three appear in the pedigree of Favourite.

[4] Duke (226) was by Comet out of Duchess by Favourite and was hence a full brother of Duchess I.

[5] The great great granddam of Holkar (female line) was by a son of Hubback.

[6] The Matchem Cow introduces more outside blood than any other animal in the table. Her sire, Matchem (2281) had four top crosses of bulls without any blood of Favourite or closely related animals as far as known certainly. Favourite appears as the fifth top sire and again as the eighth. Bolingbroke was the seventh, Foljambe the ninth and Hubback the tenth. Only the maternal grandsire of the Matchem Cow, Young Wynyard (2859), had much Favourite blood. He appears in the pedigree of Belvidere as both maternal and paternal grandsire.

[7] The fourth top sire was a grandson of Favourite and had other Favourite blood; the fifth and sixth top sires also had much Favourite blood while the seventh was Favourite himself.

TABLE II—*The coefficients of inbreeding of the Bates Duchesses and of their sires and dams, the degree of relationship between the latter and the degrees of relationship to the foundation bull, Favourite.*

		Parents			Inbreeding			Relationship			
Individual	Born	Generation	Sire	Dam	Ind.	Sire	Dam	Sire and Dam	To Favourite Ind.	Sire	Dam
A (Duchess)	....	1	J. Brown's Bull (97)	....	0	0	0	0	0.3	0.5	....
B (Unnamed)	....	2	Hubback (319)	A	0.2	0	0	0.4	6.0	11.8	0.3
C (Unnamed)	....	3	Favourite (252)	B	3.3	19.2	0.2	6.0	56.7	100.0	6.0
D (Duchess)	1800	4	Daisy Bull (186)	C	19.9	3.4	3.3	38.6	52.6	56.8	56.7
E (Duchess)	....	5	Favourite (252)	D	31.5	19.2	19.9	52.6	72.7	100.0	52.6
Duchess 1	1808	6	Comet (155)	E	40.8	47.1	31.5	58.7	76.3	80.5	72.7
" 2	1812	7	Ketton (709)	1*	43.2	31.5	40.8	63.5	72.7	72.7	76.3
" 3	1815	7	Ketton (709)	1	43.2	31.5	40.8	63.5	72.7	72.7	76.3
" 4	1816	7	Ketton 2nd (710)	1	27.9	11.8	40.8	44.5	64.5	52.4	76.3
" 5	1817	7	Ketton 2nd (710)	1	27.9	11.8	40.8	44.5	64.5	52.4	76.3
" 6	1819	8	Ketton 3rd (349)	4	43.5	33.3	27.9	66.6	60.2	61.6	64.5
" 7	1820	8	Marske (418)	3	42.5	45.7	43.2	58.8	76.8	79.9	72.7
" 8	1820	8	Marske (418)	2	42.5	45.7	43.2	58.8	76.8	79.9	72.7
" 9	1821	8	Marske (418)	2	42.5	45.7	43.2	58.8	76.8	79.9	72.7
" 10	1821	8	Cleveland (146)	4	46.3	42.4	27.9	68.7	63.6	67.8	64.5
" 11	1822	8	Young Marske (419)	5	40.6	35.6	27.9	61.6	66.4	72.7	64.5
" 12	1822	8	The Earl (646)	4	43.3	49.2	27.9	62.7	67.6	72.6	64.5
" 13	1823	9	The Earl (646)	9	47.9	49.2	42.5	65.6	74.2	72.6	76.8
" 14	1823	9	The Earl (646)	6	44.4	49.2	43.5	60.7	66.9	72.6	60.2
" 15	1824	9	The Earl (646)	8	47.9	49.2	42.5	65.6	74.2	72.6	76.8
" 16	1824	8	The Earl (646)	3	60.4	49.2	43.2	82.6	69.4	72.6	72.7
" 17	1825	9	3rd Earl (1514)	11	44.0	47.9	40.6	61.0	70.4	74.2	66.4
" 18	1825	9	2nd Hubback (1423)	6	33.2	27.0	43.5	49.1	62.9	64.9	60.2
" 19	1825	9	2nd Hubback (1423)	12	41.8	27.0	43.3	61.9	64.7	64.9	67.6
" 20	1825	9	2nd Earl (1511)	8	48.5	60.4	42.5	64.1	73.7	69.4	76.8
" 21	1825	8	2nd Earl (1511)	3	66.0	60.4	43.2	87.1	67.9	69.4	72.7
" 22	1826	9	2nd Hubback (1423)	9	37.8	27.0	42.5	56.2	70.2	64.9	76.8
" 23	1826	9	2nd Earl (1511)	11	43.9	60.4	40.6	58.4	69.5	69.4	66.4
" 24	1826	9	2nd Hubback (1423)	6	33.2	27.0	43.5	49.1	62.9	64.9	60.2
" 25	1826	9	2nd Hubback (1423)	8	37.8	27.0	42.5	56.2	70.2	64.9	76.8
" 26	1826	8	2nd Hubback (1423)	3	43.5	27.0	43.2	64.5	66.8	64.9	72.7
" 27	1827	9	2nd Hubback (1423)	16	47.2	27.0	60.4	66.0	66.4	64.9	69.4
" 28	1827	9	2nd Hubback (1423)	6	33.2	27.0	43.5	49.1	62.9	64.9	60.2
" 29	1829	10	2nd Hubback (1423)	20	42.5	27.0	48.5	61.9	68.2	64.9	73.7
" 30	1830	10	2nd Hubback (1423)	20	42.5	27.0	48.5	61.9	68.2	64.9	73.7
" 31	1830	9	2nd Hubback (1423)	26	53.5	27.0	43.5	79.3	61.8	64.9	66.8
" 32	1831	10	2nd Hubback (1423)	19	52.6	27.0	41.8	78.5	60.8	64.9	64.7

Table II—*Continued*

Individual	Born	Generation	Parents: Sire	Parents: Dam	Inbreeding: Ind.	Inbreeding: Sire	Inbreeding: Dam	Relationship: Sire and Dam	Relationship To Favourite: Ind.	Relationship To Favourite: Sire	Relationship To Favourite: Dam
Duchess 33	1832	10	Belvidere (1706)	19	32.8	52.3	41.8	44.6	68.1	64.8	64.7
" 34	1832	11	Belvidere (1706)	29	34.5	52.3	42.5	46.8	69.6	64.8	68.2
" 35	1833	10	Gambier (2046)	19	31.9	32.3	41.8	46.5	66.4	65.5	64.7
" 36	1834	10	Belvidere (1706)	19	32.8	52.3	41.8	44.6	68.1	64.8	64.7
" 37	1834	11	Belvidere (1706)	30	34.5	52.3	42.5	46.8	69.6	64.8	68.2
" 38	1835	11	Norfolk (2377)	33	31.2	19.5	32.8	49.5	60.7	55.4	68.1
" 39	1835	11	Belvidere (1706)	30	34.5	52.3	42.5	46.8	69.6	64.8	68.2
" 40	1835	10	Belvidere (1706)	19	32.8	52.3	41.8	44.6	68.1	64.8	64.7
" 41	1835	11	Belvidere (1706)	32	32.1	52.3	52.6	42.2	67.5	64.8	60.8
" 42	1837	11	Belvidere (1706)	30	34.5	52.3	42.5	46.8	69.6	64.8	68.2
" 43	1837	12	Belvidere (1706)	34	55.3	52.3	34.5	77.3	64.5	64.8	69.6
" 44	1838	12	Shorttail (2621)	37	48.5	32.1	34.5	72.8	65.0	67.5	69.6
" 45	1838	11	Shorttail (2621)	30	42.9	32.1	42.5	62.5	66.5	67.5	68.2
" 46	1838	12	Shorttail (2621)	34	48.5	32.1	34.5	72.8	65.0	67.5	69.6
" 47	1839	12	Shorttail (2621)	37	48.5	32.1	34.5	72.8	65.0	67.5	69.6
" 48	1839	11	Shorttail (2621)	30	42.9	32.1	42.5	62.5	66.5	67.5	68.2
" 49	1839	11	Shorttail (2621)	30	42.9	32.1	42.5	62.5	66.5	67.5	68.2
" 50	1839	12	Duke of Northumberland (1940)	38	40.1	55.3	31.2	56.2	63.3	64.5	60.7
" 51	1840	12	Cleveland Lad (3407)	41	32.9	11.6	32.1	54.2	55.3	47.4	67.5
" 52	1841	12	Holkar (4041)	38	36.0	24.0	31.2	56.4	58.8	60.7	60.7
" 53	1842	12	Duke of Northumberland (1940)	41	51.3	55.3	32.1	71.7	64.2	64.5	67.5
" 54	1844	12	2nd Cleveland Lad (3408)	49	32.6	11.6	42.9	51.6	56.3	47.4	66.5
" 55	1844	12	4th Duke of Northumberland (3649)	38	40.7	48.5	31.2	58.3	62.7	64.9	60.7
" 56	1844	13	2nd Duke of Northumberland (3646)	51	41.7	55.3	32.9	58.1	60.5	64.5	55.3
" 57	1845	13	2nd Cleveland Lad (3408)	50	28.8	11.6	40.1	46.1	59.0	47.4	63.3
" 58	1846	13	Lord Barrington (9308)	54	34.5	36.8	32.6	51.3	57.2	58.1	56.3
" 59	1847	14	2nd Duke of Oxford (9046)	56	42.8	32.1	41.7	62.6	57.4	56.7	60.5
" 60	1848	13	2nd Duke of Oxford (9046)	54	36.3	32.1	32.6	54.9	55.7	56.7	56.3
" 61	1848	13	2nd Duke of Oxford (9046)	51	37.8	32.1	32.9	57.1	54.9	56.7	55.3
" 62	1848	14	2nd Duke of Oxford (9046)	56	42.8	32.1	41.7	62.6	57.4	56.7	60.5
" 63	1848	13	2nd Duke of Oxford (9046)	54	36.3	32.1	32.6	54.9	55.7	56.7	56.3
" 64	1849	13	2nd Duke of Oxford (9046)	55	39.1	32.1	40.7	57.4	57.6	56.7	62.7

TABLE III—*A summary by generations (female line) of the coefficients of inbreeding and relationship for the 64 Duchesses, including Duchess I, bred by Charles Colling and purchased by Bates and the 8 generations bred by Bates.*

Generation from Duchess I	No. of Cows	Inbreeding: Individual	Inbreeding: Sire	Inbreeding: Dam	Relationship: Sire and Dam	To Favourite: Individual	To Favourite: Sire	To Favourite: Dam
0 (= Duchess I)	1	40.8	47.1	31.5	58.7	76.3	80.5	72.7
1 (Bates)	4	43.5	21.6	40.8	54.0	68.6	62.5	76.3
2 "	10	47.1	43.4	37.1	67.0	69.2	72.1	69.4
3 "	14	42.4	38.0	43.9	60.2	67.9	67.8	68.7
4 "	7	38.3	38.6	43.7	54.7	66.8	64.9	67.3
5 "	9	36.7	41.9	42.5	51.8	67.3	64.7	67.4
6 "	10	43.4	35.5	33.9	64.4	62.0	61.7	66.2
7 "	7	36.4	33.2	34.9	54.3	56.7	56.7	57.9
8 "	2	42.8	32.1	41.7	62.6	57.4	56.7	60.5
Total	64	40.9	37.5	39.6	59.2	65.6	65.1	67.2

Corn and Corn Growing

CORN AND CORN GROWING. H. A. WALLACE and E. N. PRESSMAN. Pp. 253. Price, $2.25. Wallace Publishing Co., Des Moines, Iowa. 1923.

In the preparation of this book the authors had in mind college instructors, practical corn breeders and farmers. The needs of the two latter classes have been met fairly well, but it is difficult to understand how the book can serve any useful purpose for teachers, lacking as it does even a brief bibliography. The treatment of the history, origin and botanical classification is conventional—with the exception that the origin of the dent type of grain is ascribed to the hybridization of flint and gourd seed forms.

The several methods of breeding have been summarized sanely and the conclusion reached that the method of combining inbred strains is the only remaining possibility of increasing yield.

The space devoted to heredity is largely taken up with a list of heritable characters and their symbols furnished by Professor R. A. Emerson and geneticists will welcome the appearance of this material in print. The discussion of the subject of heredity, however, is too elementary to interest the teacher and too technical to enlighten the grower.

An admirable effort obviously has been made to avoid dogmatic statements on debatable points, but there have been some failures as evidenced by the conclusion that "each row of corn corresponds to a spike and the entire ear is a combination of a number of spikes which have grown together," or that "Each ear shank contains as many nodes as the stalk bears above the ear."

The discussion of cultural practice, harvesting and testing of seed corn, marketing, cost of production and judging, is probably the best to be found in any one publication and should prove of value to corn growers.

J. H. K.

ASIATIC BREEDS OF SHEEP

Considered From the Standpoint of Tail Formation

C. C. Young
Denver, Colorado

When we consider the Asiatic breeds of sheep from the standpoint of tail development, it is possible to divide them into five groups—longtails, shorttails, broadtails, fatrumps, and fattails. The most important to us are, of course, the longtail sheep, of which there are very few in Asia, but when we do find them there they are not unlike our longtail sheep in this country, possessing from sixteen to twenty-four vertebrae and more in their tails.

The shorttail sheep, of which we have none in this country, have generally from three to five vertebrae in their tails.

Next in importance is the fatrump (*Ovis Steatopyga*) which often has no tail at all, but has two huge fat pillows that fit on the buttocks, and on cutting into these are often found embedded remnants of a tail consisting of two or three small vertebrae. Not infrequently there is a tail from two to three inches long and the thickness of a man's finger which protrudes from about the center of the fat lobules at their juncture, and which is generally covered with a very course hair varying in color. Most of the fatrump breeds are red in color, and this the reader must remember as I will speak of this particular pigment again.

Three different fatrump breeds have been brought into the United States: the Achuri from Persia by Bailey, the Khirgiz from West Turkestan by Hanson and the Kalmick from Central Asia by myself.

Where I crossed fatrumps to longtails I was able to produce broadtails (*Ovis Platyura*) of which there are a great many varieties. Indeed it is not an unusual thing to find, in this country, typical broadtail sheep that result from a cross of our native longtail sheep on the Achuri, commonly known in this country under the name of "Persian." Professor Hanson, of South Dakota, was able to produce typical broadtail sheep by crossing Khirgiz fatrumps on certain domestic longtail sheep. The Tartar, Mongol, Chulmi, Tshuiskoe, Kalmick, Buriat, Achuri, Dedick, Tshuntuk and many other Asiatic sheep are of the fatrump group.

There are a great many broadtail breeds in Central Asia and Asia Minor and in Southeast Europe, but none of them produce tight curls except the Karakuls. The Malitch of the Crimea, the Karachaev and Osetin of the Caucasus often produce very lustrous but open curls, except where they have been bred to Karakuls. The only two broadtail breeds that were ever imported to the United States, namely the Karakul and the Karachaev were brought here by myself. The latter often possess more than two horns. In the broadtail breeds we have generally the same number of vertebrae in the tail, as is the case with the longtails, but on each side of the upper three-fourths of it we find a broad triangular flap consisting mostly of adipose tissue, which gives it the appearance of a very broad tail, hence the name *Ovis platyura*.

The fattail breeds are not numerous and we have none of them in the United States. They must not be confused with the broadtail or fatrump breeds which are sometimes called, in this country, fattails. The fattail is a longtail which has up to forty-two vertebrae in its tail, which often drags on the ground. Throughout its entire length the tail is about as

BLACK FATRUMP RAM

FIGURE 26. This ram is typical of the Tshuiskoe breed of Bokhara. Most fatrump sheep are red, and it is from these red breeds that much of the deterioration in the quality of the fur-bearing Karakuls has come.

broad again as the average longtail, often broader. I am under the impression that the fattails resulted from a cross of the fatrumps on the longtails, as on two occasions I have observed among Karakuls typical fattail sheep. Suffice it to say here that the typical fattailed breed in Russia is the Voloshskaja, but there are several others.

Breeds of Fur-Sheep

There are no tight curled fur-bearing sheep among the fatrumps, fattails or shorttails, but we do find them among the broadtails and the longtails. With the exception of the Karakul and the practically extinct Danadar breeds no other sheep known has ever produced the much wanted pipe-like and pin-head tight curls. Such breeds as the Karachaev, the Osetin and other breeds of Asia Minor, and the Malitch of the Crimea (which often gives us a gray skin, "the Krimmer,") have given us beautiful, black, lustrous skins, but with open curls, as previously stated, and the same thing applies to such longtail breeds as the Tchushka of Bessarabia, the Reshetiliev and Sokoliev of Poltava. If here and there tight curled skins were produced by the Malitch breed of the Crimea, it

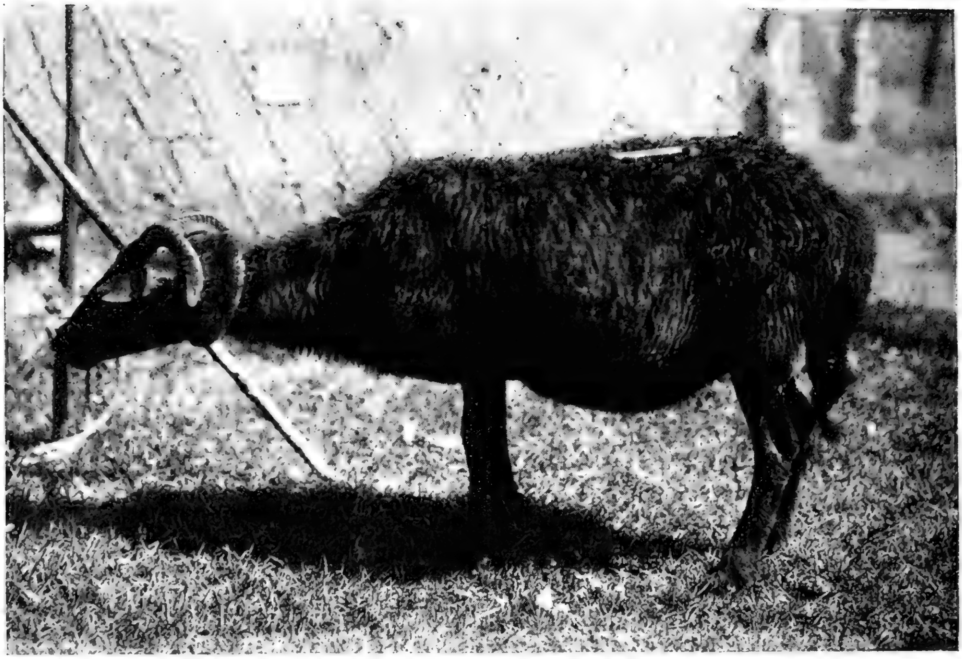
FATRUMP AFGHAN SHEEP

FIGURE 27. These sheep were photographed just after shearing, by an English engineer, A. C. Jewett, who entered Afghanistan in 1912, some months before the author.

was entirely due to Karakul admixture and the same thing must be said of the breeds above mentioned.

The Karakul owes its fur bearing qualities to the Danadar. Both breeds are indigenous to West Turkestan, Northern Persia and Afghanistan. The black Danadar, the original fur sheep of Central Asia, has become practically extinct in the past ninety years and outside of the small flock discovered by the Dragoman Petroff, of New Bokhara, and myself at Kedjumek, Bokhara, I cannot say that I have ever seen another herd, although it is possible to view occasionally a Karakul with the typical characteristics of the Danadar, the result of atavism.

I have the best of reasons to believe that had I been enabled to explore the territory on both the Bokhara and Afghan sides of the Upper Piandge I probably would have found a few more Danadars, but an expedition through that country is a stupendous task. In fact it was impossible for a foreigner to penetrate that country before the war on account of the fanatical, hostile natives and the dangerous wild animals, and moreover the laws of Russia prohibited foreigners from entering that country. There is little doubt in my mind that the black Gadir of Afghanistan is in reality the black Danadar, who has lost all his fur qualities on account of fine wool admixture of the white fine-wool Afghan sheep. The Look Nakbo of Thibet is another close relative of the Danadar and the same applies to the Osetin and

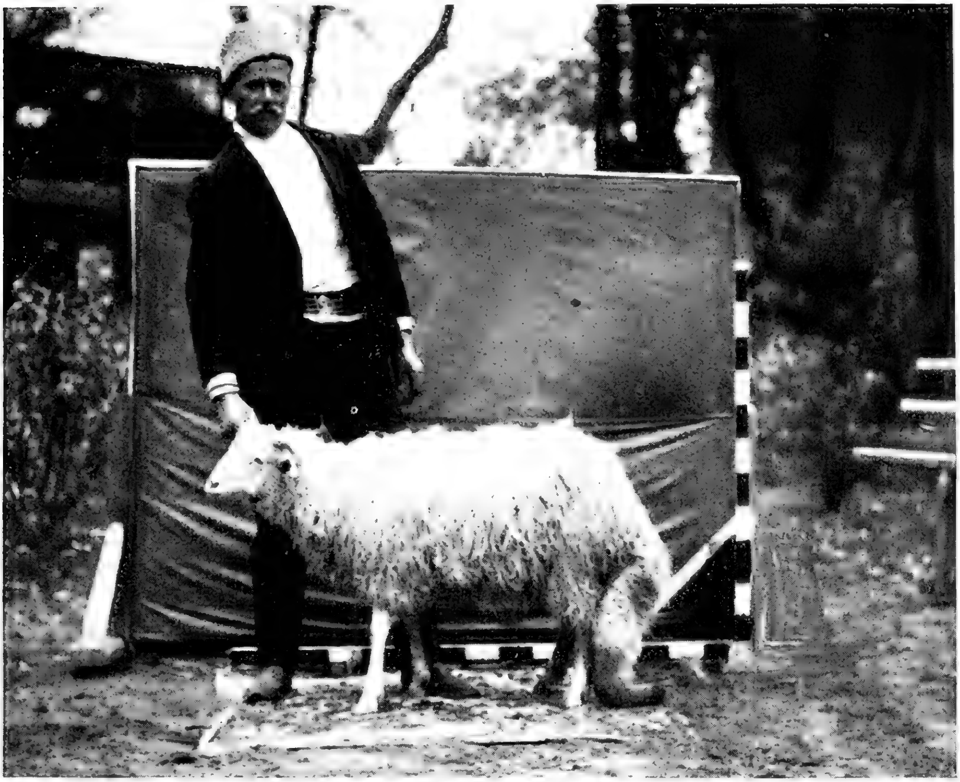


KARACHAEV EWE

FIGURE 28. This is one of the typical broadtail breeds found in North Caucausus and Asia Minor. They frequently have more than two horns. Many broadtail sheep are found in Central Asia, Asia Minor, and Southeast Europe. With the exception of the Karakuls, none of them produce skins having tight surls.

RUSSIAN SHORTTAILED AND LONGTAILED SHEEP

FIGURE 29. On the left is a shorttailed ewe of the breed called Korotkochoostja by the Russians. On the right is a longtailed Sokoliev ewe. All the domestic breeds of sheep in this country are long tailed, but this type has only a very unimportant place among the Asiatic breeds. These sheep were photographed in the province of Poltava, European Russia.



A FATTAILED RAM

FIGURE 30. The tail of this six-months-old Voloshskaja ram is already of fair size. At maturity it will wight twenty pounds or more, as will have to be supported to keep it from wearing itself out against the ground. Sheep of this type are not common in Asiatic Russia.

Karachaev of the Caucasus, the Malitch of the Crimea, the Tchushka of Bessarabia, the Reshetiliev and Sokoliev of the Poltava. The Zigai may also be included.

The original black Danadar was a small sheep with a striking resemblance to the hairy Navajo before that breed was ruined by fine wool admixture. It had thin legs, a small head with straight nose line, short erect ears, a long tail, and coarse lustrous black wool that does not become gray at maturity. This is in contrast with the case of our black Cotswolds, which turn gray when about twelve months old, and with that of the Karakuls free from fine wool admixture.

It was my great fortune to view several Danadar skins at Kedjumek. The Danadar lambs, at birth, possessed wonderful velvety lustrous skins with very small entirely closed curls, in size from that of a black pin head to that of a pea. These curls gradually open up, making it necessary to kill the lambs within a few days after birth. Otherwise the skins lose their beauty and value.

I have seen several Karakul lambs in my flock with the unmistakable pea-like curl of the Danadar. It is possible that in time we might resurrect the extinct Danadar sheep, but it would be an expensive undertaking and it is a great question whether the furrier would pay more for their skins than for the Karakul skins with tight pipe-

THE LAST OF THE DANADARS

FIGURE 31. These sheep are as pure Danadars as have been discovered in recent years, and they are considerably contaminated with fine-wool blood. The Danadar was the original fur sheep of Central Asia, but the pure breed became extinct nearly eighty years ago. Photograph by the Dragoman Petroff, Russian Embassy of New Bokhara.

like curls, known in this country under the trade name of Persian Lamb Fur.

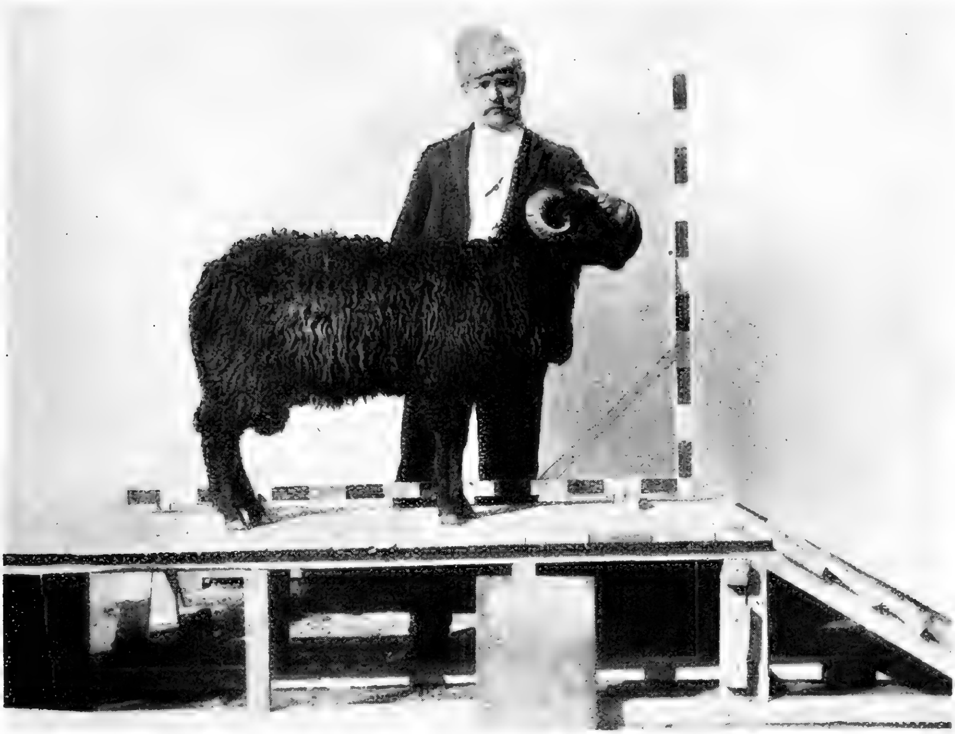
Many of the Danadar sheep that were in those sections of Bokhara lying close to the border of Afghanistan, the home of the white finewool Afghan sheep, became in time gray. Mixture of the Danadars with the fatrump breeds resulted in the development of various peculiar broad tailed breeds which we find today in Central Asia.

Those black Danadars that received but a slight admixture of the fatrump, developed a tail resembling that of half blood to three-quarter blood Karakuls in this country.

No Pure Breeds in Central Asia

The grade Danadar just discussed is the sheep which Dr. Sinitzin found some forty years ago near the Lake of Kara Kul where many Arabs were engaged in sheep raising, and those of their sheep that produced lamb skins of greater value were called "Arabi."

In studying Sinitzin's description of the Arabi, one encounters the same characteristics as are found in the black Danadar, except that the Arabi turn gray at maturity which is not the case with the black Danadar. Sinitzin even speaks of the Arabi as being practically a longtailed sheep. It is easy to understand why Sinitzin saw more of the so-called Arabi than anyone who visited Bokhara twenty to twenty-five years later, since the natives have for years made it a practice to kill the lambs with the most valuable skins. Some investigators realized that



A RESHETILIEV RAM

FIGURE 32. This breed is a close relative of the extinct Danadar. Like the Danadar they have long tails.

it was a difficult matter to speak of any distinct *breeds* of sheep in Central Asia, as we use the word in this country, since the flocks of the natives consist of a mixture of all imaginable kinds of hybrids. The writer is not alone in speaking of the Karakul as being a mongrel sheep. Karpoff, of the Russian Department of Agriculture, is making that quite clear in his bulletin, and one needs but look at a flock of Karakuls to satisfy himself that he is looking at anything but pure bred animals. Only where the closest inbreeding has been practiced is there a semblance of uniformity of type and unfortunately that is accomplished at the expense of the tightness of the curls, upon which the real value of Karakul lamb skins depends, as close inbreeding tends to make the wool finer.

I might explain here that the word "Karakul" covers a multitude of sins in Central Asia and only about one out of a hundred of the so-called Karakuls has enough of the Danadar strain in it to produce the tight curls so much desired.

When it comes to the large Arabi which Sinitzin describes, he could not possibly have meant anything other than the large Karakul, also known as Doozbai. What is more natural than to expect a hybrid, resulting from a cross of the small Danadar upon a fatrump, to possess the characteristics of the fatrump? The typical fatrump possesses a large body, in fact is the largest sheep in the world, with a large generally hornless head, a convex nose line, long drooping ears, thick legs, coarse brittle hairy fleece, generally red. Sinitzin's large Arabi possesses

BROADTAILED SHEEP OF THE CRIMEA

FIGURE 33. The lighter Malitch sheep generally produce a gray fur with open curls, the "Krimmer." The black animals often produce tight curls, due to the prepotency of the Danadar strain, obtained by crossing with Karakuls. Gray skins with tight curls are very rare, and few ever reach this country. Such skins are only produced by a large type of Karakul sheep called Doozbais, and the skins are called "Shiraz," a name sometimes also applied to black skins when the curls are small and very tight.

AFGHAN FINEWOOL SHEEP

FIGURE 34. By mixture with the finewool breeds the fur sheep industry of Central Asia is being rapidly and permanently ruined, as Karakul sheep contaminated with this strain will not produce skins with the prized tight, lustrous curls. The shepherds are Afghans, photographed by the author at Karshi, near the border of Afghanistan.

all of these characteristics except that some of the bucks are horned, come black at birth, turn gray at maturity, and the tail formation is such as to make them typical members of the broadtail breeds. It is true that Sinitzin's Doozbai contains much more fatrump admixture, evidenced by a broad tail of tremendous size. While many of them have enough black Danadar in them to come black, the majority of them come red, and in selecting them one should avoid those specimens in which the tail bears too close a resemblance to the fat pillows of the fatrumps.

As far as Sinitzin's Shiraz is concerned, that is largely a myth, but one finds, here and there, a typical Doozbai whose offspring come gray. The white is no doubt due to the little white Afghan finewool, the black that of the Danadar, and the red (I have seen Shiraz skins with all three of these colors) that of the fatrump. In all my three importations I brought only

one Shiraz to this country and I am asking myself today why I wasted my money on him, as the gray skins produced by these peculiar accidents of atavism are almost invariably with open curls and therefore can easily be imitated by kid skins, which the furrier can buy for fifty cents apiece.

I have decided that the proper thing for the American breeder to do is to call all Central Asiatic sheep of the general type that I have brought to the United States Karakuls and to forget about everything else, as it is most confusing. It suffices to tell a novice that Karakuls are of various sizes and are not bred with a view of attaining uniformity of type, unless one is breeding them for mutton purposes; that the only thing that really counts is tightness of curl, and that all rams that fail to sire lambs with such curls in the first or second cross should be eliminated.

I have asked many specialists what caused the tight curl in the Karakul, or of the Negro in the genus Homo. Some thought it was due to keratin, which is more abundant in the coarser wooled breeds than is the case in the finewools. That keratin gives us a certain stiffness, which causes the curl to remain closed, is possible. I know from numerous tests made by Professor Wallace of Edinburgh, Simonson, myself and others, that the Merino and Rambouilette will not give us even a semblance of tight curl formation in the first cross, in fact not even in the second cross, while certain coarsewools have often given us beautiful tight curls in the first cross. I would like to refer the reader to the bulletin issued by Professor Wallace which appeared in the Journal of the Board of Agriculture, August, 1915, which is printed under the authority of His Majesty's Stationery Office. Both rams mentioned were furnished by myself. But if keratin is the "Hauptgrund" then why does the wild Argali lamb, or some of the fatrump lambs of Central Asia, that have a coarser fleece than the best Karakuls, not come with tight curls? The same may be said of the Rocky Mountain sheep.

Errata

Huxley, Julian. *Glands and Development.* Vol. XIII, Pages 351 and 353. The statement under Figures 8 and 9 that thyroid extract *or iodine* produces metamorphosis in axolotls is an editorial error. In the fourth line under Figure 8 the words *iodine or* should be deleted. In the first line under Figure 9, for Iodine, read Thyroid.

Dunn, Schneider and Webb. *Inheritance of Spotting in Holstein Cattle.* Vol. XIV. Page 236. Thirteen lines from top of left-hand column, change 555.4 to read 455.4.

Garber and Quisenberry. *Origin of False Wild Oats.* Vol. XIV. Page 270. Fourth line under Figure 10, change *Avena nuda* to read *Avena fatua.* On page 268, five lines from bottom of left-hand column, read *second* generation.

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RASPBERRY BREEDING

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BALTIMORE, MD. AND WASHINGTON, D.C.

Volume XIV, Number 1 April, 1923

Special Notice To Members
(INSIDE FRONT COVER)

SPECIAL NOTICE TO MEMBERS

Beginning Volume XIV

As explained in the last issue of the Journal, the reckoning of numbers and volumes has had to be changed on account of a recent ruling of the Post Office Department, which requires the Journal to bear the designation of the current month in order to be mailed as second class matter. Accumulated delays in publication during the war period, which it has been impossible to overcome, resulted in the tardy issuance of the Journal that we must now remedy.

As the most practical way of meeting the difficulty the Council has voted to set membership dues ahead six months, from January to July, and to mark the current issue as the beginning of a new volume, to avoid disturbing the normal relation of the volumes to the calendar years. Although Volume XIV will consist of only nine numbers, it is considered that this inconvenience will be only temporary and cause much less trouble eventually than other ways of adjusting the difficulty.

The May number is nearly ready and will be issued in a few days.

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DOUBLE AND TRIPLE PEACHES

ABNORMAL FLOWER OF WATER LILY

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The Journal of HEREDITY

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JUNE, 1923

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BALTIMORE, MD. AND WASHINGTON, D.C.

Volume XIV Number 3

IN FUTURE NUMBERS

Chromosomes in Drosophila, two papers by Charles W. Metz and Mildred S. Moses, summarizing what is now known about the carriers of heredity in the fruit fly and its relatives.

Biology in Human Progress, by O. F. Cook. Is civilization subject to fixed cycles of growth and decay, or can the destructive forces be analyzed and their action arrested by the application of biological principles to human affairs?

Naked Oats, by T. R. Stanton. The story of a variety that has been a boon to dishonest seedsmen for a generation.

Freshman Matrimonial Ideals, by Robert T. Hance. The obverse, or rather the reverse of the usually gloomy result of inquiring into the college birth-rate, perhaps because prospective families are considered rather than actual ones.

Age and Area, by Hugo de Vries. Are the most widely spread species the oldest?

Intersexes in Nematodes, by G. Steiner. Few people know what a nematode is, let alone what it looks like. We hope that this article will serve as an introduction to one group of this interesting but little known branch of life.

Inheritance of Spotting in Holstein Cattle, by L. C. Dunn, H. F. Webb, and M. Schneider. How much of the variation in the amount of spotting seen in this popular breed is hereditary?

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Volume XIV Number 4

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